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Soil and Vegetation of Herschel Island

Report No. 1 Yukon Soil Survey 1989

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Soil and Vegetation of Herschel Island

Report No. 1 of the
Yukon Soil Survey

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PREFACE

This report contains a summary of soil and vegetation properties catalogued during the SIL 2 (semi-detailed) ecological survey of Herschel Island, Y.T.

Soils from ten soil subgroups and eleven vegetation communities have been organized into eight mapping units each with a specific range of soil, landscape and vegetation properties. Interpretations for recreation, engineering and arctic fox denning habitat are presented either on maps or within the text of this report.

This report provides background documentation in support of the following maps:

1. a 1:25,000 ecological map of Herschel Island,

2. a 1:2,000 interpretive map with a polygon-specific legend for engineering and physical properties of soils of the settlement area at Pauline Cove,

3. a 1:25,000 interpretative map of arctic fox denning habitat, (available separately from Fish and Wildlife Branch, Department of Renewable Resources, P.O. Box 2703, Whitehorse, Y.T. Y1A 2C6).

The principal function of the report is to provide a catalogue of soil morphologies and vegetation descriptions that can be of use to ecologists working in similar low-arctic environments. Analytical data and tabular summaries are presented in the appendices.

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1. INTRODUCTION

1.1 Background

The Inuvialuit Final Agreement is the Western Arctic indigenous peoples' land claim settlement. It was signed in 1983 between the governments of Canada, Northwest Territories, Yukon and the Committee for Original Peoples' Entitlement (C.O.P.E.). Section 12(16) of the agreement specifies that under the jurisdiction of the Government of Yukon, Herschel Island is to be established as the Herschel Island Territorial Park and that the park regime on Herschel Island is to be no less stringent than that of the National Park agreed to be established at the same time on Yukon's North Slope (Indian and Northern Affairs Canada, 1984).

During the fall of 1984, in response to these specifications, the Yukon Department of Renewable Resources requested the initiation of a park planning project that included a requirement for soil and vegetation inventory of the island. Field work was conducted cooperatively by staff of the Yukon Department of Renewable Resources and Agriculture Canada during July and August 1985 and briefly during July 1986. The objective of the ecological (soil and vegetation) survey was to provide park managers and planners with information, principally in map format, that would be useful in preparing park plans and interpretive material on the natural history of Herschel Island. This project marks the first detailed soil and vegetation mapping to be conducted in northern Yukon.

1.2 Location

Herschel Island is approximately 100 square km in size and lies in the Beaufort Sea 3 to 6 km from the Yukon coast (Figure 1). The centre of the island lies at 69°30' N latitude, 139° W longitude some 1000 km north of Whitehorse or 2350 km N.W. of Vancouver, B.C. Herschel Island lies at the extreme N.W. corner of Canada, on a portion of N.T.S. sheet 117D.

1.3 Climate

The closest weather station with long-term weather records for the Yukon arctic coast is situated at Komakuk Beach approximately 50 km west of Herschel Island. Monthly mean temperature and precipitation values are presented in Figure 2. Mean annual temperature is -11.4°C with 135 mm of precipitation (Atmospheric Environment Service 1982).

The warmest month of the year is July with a mean daily temperature of 7.5°C and the coldest is February at -27.5°C. Precipitation distribution is strongly skewed toward the summer when the Beaufort Sea is ice-free. The temperature distribution

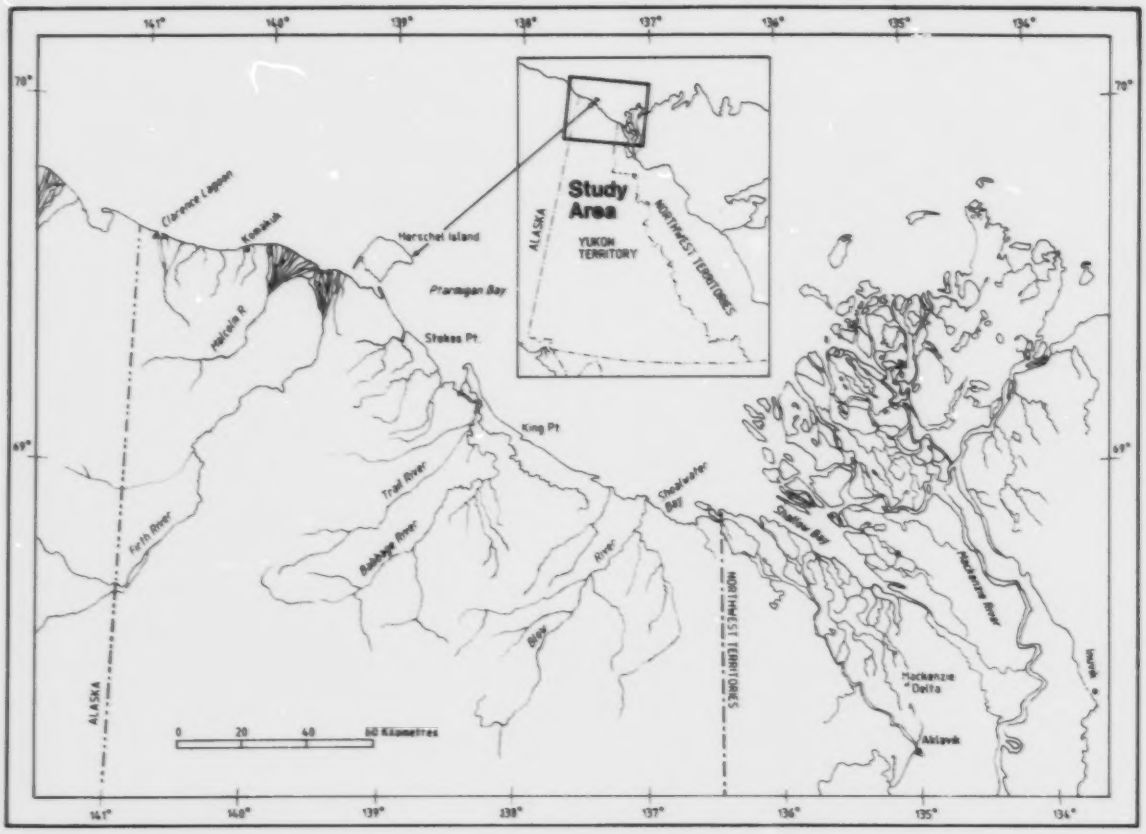

Figure 1. Location of the study area.

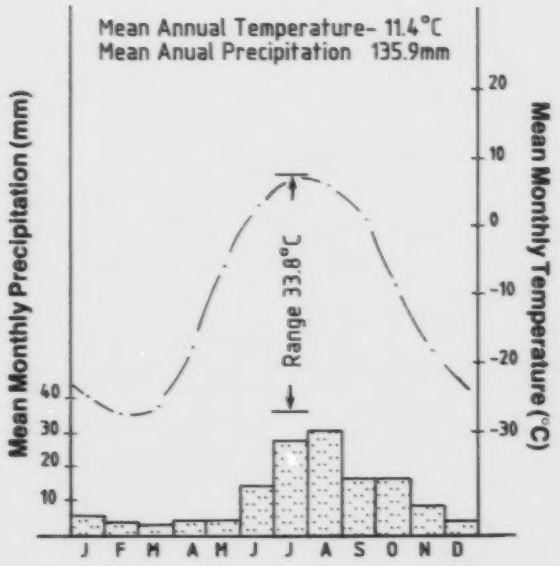

Figure 2. Graph of the distribution and range of monthly precipitation and temperature values at Komakuk Beach, Y.T. (69°35'N, 140°11'W, 14 m asl) (Atmospheric Environment Service, 1982).

is more continental in nature than coastal, a result of ice cover most of the year in the southern Beaufort.

1.4 Previous Studies

The first Europeans to visit Herschel Island were members of Franklin's First Expedition in 1822-23. The island was named by Sir John Franklin after the astronomer William Herschel. The Inuit of the region inhabited the coastline areas of the island where food could be obtained from the ocean with relative ease. Pauline Cove on the eastern end of Herschel Island was first used as a wintering harbour by American whalers in the Beaufort region in the late 1890's.

The Royal North West Mounted Police established a depot at Herschel settlement shortly after the turn of the century and manned the post up until 1964. The first scientific observations of the geology of the region were undertaken by the members of the Canadian Arctic Expedition of 1913-18 and were reported by O'Neill (1924).

Initial physiographic studies along the Yukon's north coast were conducted by the Geological Survey of Canada. Bostock (1948) described numerous physiographic units including the Yukon Coastal Plain. Mackay (1959) undertook the first detailed sedimentological studies along the north coast, including Herschel Island. He was the first to describe the deformation features of glacial ice-thrust as found on Herschel Island. Fyles (1966) described the regional Quaternary stratigraphy of the Yukon coast. With the anticipation of the Arctic Gas pipeline from Alaska, a tremendous amount of inventory in a range of disciplines occurred during the 1970's. Of most relevance to this survey report were the efforts of Bouchard (1974) who conducted the first detailed examination of the stratigraphy of Herschel Island and made passing references to the soil development on the island. Rampton (1982) summarized the Quaternary geology of the region. Tarnocai (1978a) completed the first soil map of northern Yukon and included Herschel Island in his study area. The exploratory nature of his mapping (1:1,000,000) dictated that ground observations were few and only a limited soil examination of Herschel Island was possible.

The history of plant collecting on Herschel began in the early 1900's with specimens now stored in herbaria around the world.

The earliest botanical records date to the 1903-1906 Gjoa Expedition of the Royal Dutch Navy, when Chief Steward A.H. Lindstrom collected vascular plants and bryophytes (Hulten, 1940). The Gjoa, under Capt. Rould Amundsen, was the first ship to complete the navigation of the Northwest Passage. In 1913, Rev. Isaac O. Stringer assembled a collection of vascular plants

while posted at the Anglican Church Mission at Pauline Cove. Fritz Johansen collected vasculars and bryophytes in 1914, as a member of the 1913-1918 Canadian Arctic Expedition (Macoun and Holme 1921). In 1953, C.D. Bird assembled a small plant collection while working for the Canada Department of Agriculture, in cooperation with the Canada Defense Research Board (Cody, 1987; pers. comm.). G.W. Scotter made collections of both lichens (Brodo 1987, personal communication) and mosses (Steere and Scotter 1978) on the island in 1972. P.F. Cooper collected lichens in 1977 (Brodo, 1987).

Brief vegetation description and mapping of communities was prepared by R.M. Hardy and Associates (1979) during the course of environmental impact studies for proposed hydrocarbon extraction development and port development in the Herschel Basin of the Beaufort Sea.

Wiken et al (1981) summarized the vegetation and ecological features of Herschel Island with the ecological land survey of the northern Yukon. Again, this was exploratory work and only brief reference is made about the soil and vegetation of Herschel Island.

1.5 Physiographic and Geomorphic Origins of Herschel Island

Herschel Island has been included as part of the Yukon Coastal Plain by Rampton (1982). The Yukon Coastal Plain is a pediment, a geomorphic unit formed by the parallel retreat of escarpments in areas of arid or semi-arid climate usually under a non-periglacial climate. Pediments are characteristically noted by the abrupt change between hills (in this case the British Mountains) and plains (Twidale 1968). The age of the erosion surface or pediment along the Yukon Coastal Plain is probably late Tertiary. Today, most of this erosion surface in the unglaciated part of the coastal plain is covered by low angle fine textured colluvial aprons interspersed by numerous large sand and gravel alluvial fans (Rampton 1982).

Herschel Island owes its origin to Pleistocene glacial activity along the Beaufort Coast. Mackay (1959) originally proposed glacial ice-thrusting as a mode of formation for the island. More recent studies (Bouchard, 1974; Rampton, 1982) have corroborated this origin and provide a background to understanding the geomorphology and soil development of the island.

Deformation of Pleistocene or earlier sediments has occurred along most of the Yukon coast between King Point and Herschel Island. The age of glaciation that caused the deformation is uncertain. Rampton (1982) estimated the age of this glaciation at >40 ka ago and attributed it to his early Wisconsinan aged Buckland Glaciation. However, Dyke and Prest (1987) have shown a

glacial limit beyond Herschel Island at 25 ka ago with a late Wisconsinan (13 ka) position within the area of the Mackenzie Delta (Figure 3).

Herschel Island was formed by the movement of glacier ice as it advanced to the northwest. The ice front ploughed up the frozen sediments by its forward motion, buckling and folding the sediments and forming a push moraine. Southeast of Herschel Island, a basin (Herschel Basin) within the sea floor has volume of sediment missing that roughly corresponds to the volume of Herschel Island. Further evidence to support the push moraine theory are the linear troughs and ridges on the northwest part of the island that are presumed to have formed subparallel to the snout of the glacier. This ice-thrust or push moraine consists of a mass of frozen deformed sediments reaching a maximum elevation of almost 200 m above sea level. The sediments are considered to be principally marine, non-marine and of mixed origin (Bouchard 1974). Mixed sediments are representative of terrestrial near-shore and shoreline environments and consist of gravels, sands, and organic detritus. These may be overlain and/or underlain by marine clays and silts.

Although the deformation of the sediments can be traced to Buckland glaciation, the age of the sediments is unclear. The origin of all these materials is thought to be related to pediment formation associated with development of the Yukon Coastal Plain. The sediments are likely to be in past pre-Wisconsinan (>80,000 years B.P.). The sequences of sediments that make up Herschel Island were initially deposited during a time when the landscape was covered variously by boreal forest, forest-tundra and shrub tundra (Rampton 1982).

Since glaciation, the most significant processes affecting the morphology of Herschel Island have been the rapid coastline retreat and upland surface erosion. The phenomenon of rapid coastline retreat is unique even within periglacial environments, and is found only in the western Canadian Arctic and Siberia (French 1976). This retreat is due primarily to thermal erosion of ice-rich unconsolidated sediments. The normal coastline erosion processes do exist, but are subdued. Wave action is limited by several factors: the very short ice-free period, the presence of off-shore pack ice which diminishes the magnitude of the wave fetch; and the late spring and early winter presence of an "ice-foot" along the beach which decreases the effective duration of wave action. Therefore, measured by the usual coastal processes, Arctic beaches are relatively low-energy environments.

Since glaciation, it is believed that the southwest shore of Herschel Island has retreated by 1 to 2 km (McDonald and Lewis 1973). Thermal erosion works in two ways on Herschel Island; it exposes ice bodies such as ice wedges and ice masses in the

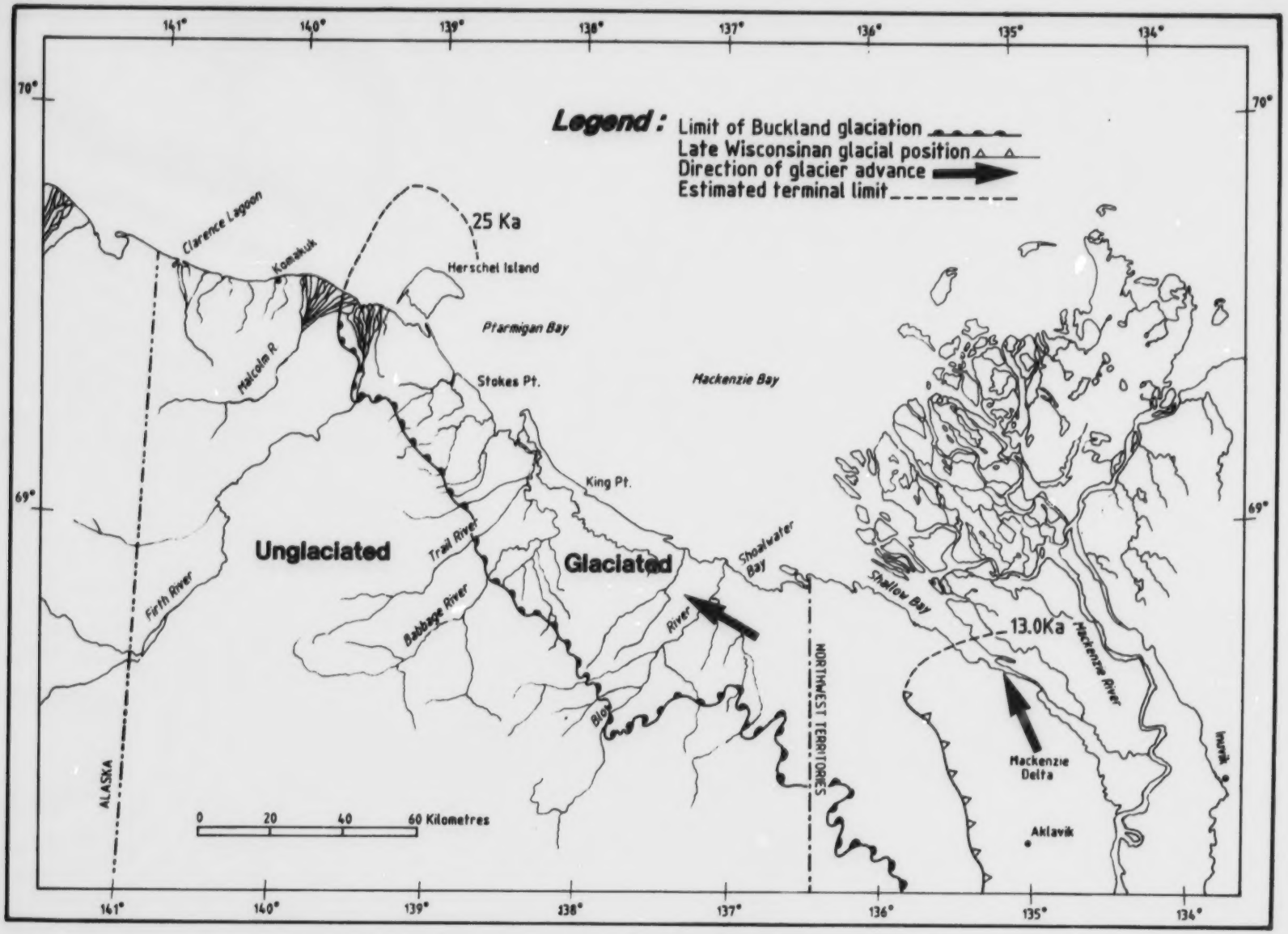

Figure 3. Glacial limits along the Yukon coast. The Buckland Glaciation was most extensive but its age is unclear. Late Wisconsinan glacial position was within the Mackenzie delta region (adapted from Rampton, 1982 and Dyke and Prest, 1987).

sediments, inducing rapid melting and slumping of the face, or it forms thermoerosional niches at high tide level causing undercutting of the bluffs which eventually collapse. Some coastlines in the western Arctic are known to erode at a rate of 2-4 m per year (French 1976, p.211).

In a similar fashion, upland erosion is triggered by both water and thermal processes. Active-layer thaw, snowmelt run-off and strong gullying as a result of 180 m relief between the island's upland plateau and the coastline, all contribute to erosion. Gully erosion exposes ice-rich sediments which thaw releasing sediment and water that flow all summer promoting yet more erosion. Along much of the coastline numerous spectacular features of thermal erosion initiated by shoreline and gully erosion can be observed (Figure 4).

The net effect of the rapid erosion is the strongly gullied landscape and shoreline depositional features such as bars and spits. The high sediment load released into a relatively shallow nearshore environment by the erosion of the coastline, as well as the sediment influx from the Mackenzie River promote shoreline deposition at certain locations around the island.

1.6 Periglacial Features

The island exhibits excellent examples of periglacial features such as ice wedges and ice wedge polygons, earth hummocks, non-sorted patterned ground and solifluction lobes.

Ice wedges are numerous on Herschel Island and can be observed in various stages of development and under various geomorphic conditions. Current development of ice wedges (and their associated polygonal surface pattern) occurs on poorly drained tundra within the upland of the island. A rapid drop in temperature to below -20°C in the fall and winter leads to contraction of the ground and development of thermal cracking. During the spring, water runs into the cracks where it eventually freezes and prevents the ground from closing completely (French 1976). Ice wedges grow slowly, generally less than 1 mm per year although at Illisarvik on the Tuktoyaktuk Peninsula, 8 cm wedges have developed in seven years (C.R. Burn, personal communication). A polygonal net is produced as ice wedges intersect each other.

Throughout the upland area, less distinct ice wedges can be observed. These are best seen in the headwalls of retrogressive thaw slumps and can be up to 10 m across and 10 m in depth (Figure 5). Ground ice in other forms (in addition to ice wedges) can be seen in these exposures to make up a significant proportion of the total volume of the island. Ground ice may make up to 50% of the volume of near surface permafrost on Herschel Island (Mackay et al., 1971).

Figure 4. Large retrogressive thaw slump located approximately 5 km southwest of Herschel settlement. Note two additional scars in upper left hand corner of the photo.

Figure 5. Ice wedges exposed in the headwall of a retrogressive thaw slump. The tops of the wedges are approximately 10 m across and represent the level of the present permafrost table.

Earth hummocks and patterned ground are another prominent feature of the landscape. These features are common on moderately well drained convex landscape positions. Non-sorted nets, circles and stripes (Washburn, 1980) are the most common patterned ground features on the fine-textured soils of Herschel Island. These develop as the result of cryoturbation (i.e. frost churning) acting in the fashion of a thermal convection cell. Upwelling in the center of the cell produces unvegetated patches of soil in circular patterns. Where many patches occur together nets are formed. On slopes, circles tend to elongate downslope and stripes form. The soils associated with these features are Turbic Cryosols (CSSC 1978) which are characterized by disturbed and discontinuous horizons and incorporated and buried organic matter.

Solifluction (movement induced by gravity) and frost creep (movement resulting from freeze/thaw) occur on all gentle slopes. These processes produce the seasonal downslope movement of thawed materials above the permafrost table. Observations during the tow years of this survey on a complex slope between 5% to 10% indicated rates of movement within a range of 1 to 5 cm per year, consistent with rates as reported by French (1976) for nearby Bank Island. Mackay (1981) reports movement of 0.5 - 1.0 cm/year on Garry Island that he attributes largely to plug-like flow at the end of the summer. In wet sedgey swales, he reported movement rates of up to 2 cm/year.

Solifluction and frost creep produce the characteristic terracettes and lobes common on all vegetated slopes. These processes are continuous, unlike the episodic rapid mass movement associated with thermal erosion on some of the steeper slopes in the study area.

Periglacial features are discussed further within the context of the map units defined for the Herschel Island mapping project.

2. SOIL SURVEY METHODS AND CLASSIFICATION

2.1 Methods of Survey

Prior to field surveying, available aerial photography was examined to gain an overview of the island's geomorphology and vegetation cover. Because of the origin of the parent geological materials, a preliminary mapping legend was formulated based on identifiable surface forms and vegetative features. In the field, information was collected about the soil and vegetation conditions of each of the defined map units. Ecological map units are described in Section 4.

Map polygons were delineated on 1:12,000 black and white aerial photographs. While on daily traverses across the study area, field surveying concentrated primarily on describing vegetation and soil development within delineations and to a lesser extent on checking polygon boundaries.

Thirty six days were spent on the field survey, totaling approximately 138 person-days of inventory effort covering an area of approximately 10,000 ha. Soil information was collected in conjunction with the vegetation survey (see Chapter 3). The intensity of field inspections for the preparation of the 1:25,000 ecological map of Herschel Island approximates the specifications for a survey intensity level (SIL) 2 inventory. Use of an intensity index based on inspection density and distribution was calculated in ha as 0.33 (Valentine and Lidstone, 1985). This falls into the upper range of their reported SIL 2 values.

A total of 425 soil inspections were made in a variety of detail, for a range of inventory purposes. Of these, 125 were routine site and profile descriptions prepared from observations made on daily traverses at sites that were considered to represent local conditions. Following the completion of the initial survey and establishment of a final map legend, two detailed profile descriptions with associated horizon sampling were undertaken for each of the eight major map units defined for the island. These samples were used for analytical characterization (Appendix 1). Survey crews also made approximately 100 "stops" where notes on soil or landscape conditions were made to confirm polygon descriptions.

Systematic collection of data was taken from each of 15 selected polygons representing the eight map units. Transects were composed of ten uniformly spaced observations oriented along the long axis of the polygons.

Two peripheral studies allowed the collection of additional soil data. In conjunction with a study of arctic fox habitat, 12 detailed soil descriptions and sampling were completed on and near, selected arctic fox dens (Smits et al., 1987). Also a study to evaluate the engineering conditions of the Herschel settlement spit resulted in the collection of information at an additional 20 sites and the preparation of a 1:2,000 map of this area. These observations documented soil grain size distribution, water table and permafrost table levels.

A portable gasoline powered drill was used at selected sites to observe soil and ice characteristics of the permafrost immediately below the active layer (Figure 6). The drill was equipped with a special auger that allowed the collection of continuous cores 7.5 cm in diameter to a depth of 3 m.

The survey of Herschel Island had an overall inspection density of one inspection per 24 ha of land, although observations were not uniformly distributed within the survey area. It is estimated that approximately 70% of the polygons on the 1:25,000 ecological map have had one or more inspections. Most polygons on the 1:2,000 map of Herschel Island Settlement area had some form of inspection.

2.2 Methods of Sampling and Analysis

Selected soils were described in detail in the field according to Day (1983) and classified according to the Canadian System of Soil Classification (CSSC, 1978). Soil samples were air-dried and later sent to Analytical Services Lab at the Land Resource Research Centre in Ottawa for analyses. All analyses follow the procedures described by (Sheldrick 1984). Profile descriptions of representative pedons and accompanying analytical data are presented in Appendix 1.

2.3 Soil Formation

Soil formation proceeds slowly in this low-arctic environment. Chemical weathering is retarded due to cold temperatures and low precipitation. Physical processes and mechanical weathering are major factors in producing the soil morphologies in the study area.

The vast majority of soils on Herschel Island are fine-textured and belong to the soil temperature class of extremely cold; the mean annual soil temperature at 50 cm depth is estimated to be $<-7^{o}C$, the mean summer soil temperature is $<5^{o}C$, and there is no warm thermal period when mean daily air temperature is $>15^{o}C$ (CSSC 1978). Soil active layers are seldom greater than 50 cm in depth and are less than 30 cm on many level upland surfaces (Figure 7). The island is underlain by continuous permafrost. The only landscape positions where permafrost does not lie within

Figure 6. Hand-held portable drill used to collect soil samples from permanently frozen soil horizons. It is a conventional fence post hole auger power unit adapted with a permafrost bit and 7.5 cm diameter core collector.

Figure 7. Typical cryosolic soil profile showing active layer composed of numerous cryoturbated horizons and the permafrost table with characteristic irregular upper boundary.

1 m of the surface are on some raised marine backshores, on localized eolian (dune) landforms and some faunally-altered microsites. Even on these landforms, permafrost lies within 2 m of the surface.

Soil formation is greatly influenced by mass movement. As gully erosion proceeds on the highly erodable, fine-textured, ice-rich sediments of the island, a strongly dissected topography begins to form. Slopes undergo mass movement, both episodic and ongoing (gelifluction). This results in continuous movement and rejuvenation of soil materials within the active layer on all but the most level landform surfaces.

The undisturbed active layer moves gradually downslope by several processes, the most important of which are frost creep and gelifluction (Washburn 1980). Mackay (1981) has described this movement of the active layer as "plug-like", that is with greatest movement occurring within the middle zone of the active layer producing a vertical velocity profile convex downslope.

The hummocks that move remain intact. The movement occurs in late summer with sliding along a thawing, ice-rich, organic horizon (Ahyz) at the bottom of the active layer. Hillslope movement is usually less than 1 cm/year (Mackay 1981).

Nonsorted patterned ground has widespread occurrence on level and gently sloping terrain on Herschel Island. The surface expression of nonsorted patterned ground is bare patches of soil with small polygonal dessication cracks on the surface, surrounded by vegetation. When excavated, a permafrost table with a mirror image to the ground surface is found (Shilts, 1977; Mackay, 1979). Nonsorted patterned ground can occur in fine grained soils such as till, marine clayey silts, colluvium or any other poorly sorted mud with significant silt and clay content (Shilts, 1978).

There are many explanations proposed for the genesis of nonsorted patterned ground. Nicholson (1976) and Crampton (1977) believed it was due to cryostatic pressure; Shilts (1974; 1977) explains patterned ground as being a result of loading and artesian pressures; Mackay (1979) has proposed an equilibrium model and Tarnocai and Zoltai (1978) have described hydrostatic pressures resulting from two freezing fronts which produce expansion and mound creation.

All models incorporate unit cell convection movement but give different explanations as to why this happens. Patterned ground may be polygenetic in origin (Mackay and Mackay, 1976), and may result from differential pressures caused by different material densities. Loading pressures from animals on the surface may, under some circumstances, also contribute to "mudboil" development (Shilts, 1977). Patterned ground activity may be triggered by any unusual amounts of moisture such as heavy rainfall.

Chemical weathering in nonsorted patterned ground is generally very slow due to cold climate. (Hill and Tedrow, 1961.) Mechanical weathering is more prominent and is mostly due to frost action, especially the formation of ice lenses. Desiccation networks and sliding may give secondary features (Van Vliet-Lanoe, 1984; 1985). Fine-grained sediments are susceptible to frost action and ice lenses grow in them parallel to and behind the freezing plane at the expense of the moisture content in the unfrozen material. This results in the growth of desiccation networks, and aggregation of soil particles. As the ice lenses grow, moisture is drawn by capillary action and suction to the ice lenses behind the freezing plane, leaving stable cracks and fissures (Van Vliet-Lanoe, 1985; Van Vliet-Lanoe and Coutard, 1984).

In the case of very rapid freezing in fine-texture soils, prism like structures can form. Stable aggregates are also formed by the compactional forces created by the growth of the ice lenses; compressional forces can be as strong as 14 kg/cm^2 (Van Vliet-Lanoe, 1985). Ice lenses are more closely spaced near the surface as the cooling rate is faster here; this results in bladed or platy aggregates forming near the surface. With further freezing and thawing, and with lateral stress or rotation of the aggregates, they can become granular through plastic deformation (Van Vliet-Lanoe and Coutard, 1984). Fox (1979) described numerous micromorphological properties exclusive to the Turbic Cryosols that indicate continual movement and reorganization of soil materials within the active layer.

Surface soil horizons formed within fine-textured parent materials on the island often exhibit moderate to strong granular or fine subangular blocky structure. This well developed soil structure along with broken and distorted horizons resulting from active cryoturbation processes, are the most prominent morphological features of most of the soils within the study area.

The nearly continuous presence of permafrost within 1 m of the surface places most soils into the Cryosol order of the Canadian Soil Classification System (CSSC 1978). Cryosolic soils occupy approximately 40% of the area of Canada and are by far the most wide-spread soil of northern Canada (Tarnocai 1978b). The following is a brief outline of the major soil great groups (Turbic Cryosols, Static Cryosols) and some other soils observed in the study area.

2.3.1 Turbic Cryosols

The most common soil taxa on Herschel Island is the Orthic Turbic Cryosol. These soils are subject to strong cryoturbation producing poorly defined and disrupted soil horizons (Figure 8 and Table 1). They occupy relatively stable landscape surfaces

Table 1a. Site and pedon description for an Orthic Turbic Cryosol formed under non-sorted stripes.

SITE DESCRIPTION:

Site No:	314
Unit Name:	Plover
Location:	69° 55′N, 139 ° 05′W
Elevation:	160 m asl
Slope:	7%
Drainage:	Moderately well
Active layer thickness:	20-40 cm
Vegetation:	Arctic Willow/Dryas-Vetch
Parent Material:	Clayey marine, overlying sandy marine sediments
Soil Classification:	Orthic Turbic Cryosol, fine loamy over sandy, mixed, neutral; strongly calcareous, extremely cold humid.
Representativeness:	This pedon was described under non-sorted stripes on a gentle mid-slope position. A landscape cross-section is presented in Figure 6. High organic carbon content in the lower solum is inherited from the marine parent material. The granular structure of the Bmyl horizon is very prominent. Horizon depths are omitted due to the extremely cryoturbated nature of the profile.

PEDON DESCRIPTION

Horizon	Description
Ahy	Dark brown (7.5 YR 3/2 m), very dark grey (10 YR 3/1 d); silty clay loam; very weak, fine to medium, subangular blocky; friable, slightly sticky; few, fine and medium roots; clear, broken boundary; 0-8 cm thick; neutral.
Bmyl	Very dark greyish brown (10 YR 3/2 m), olive grey (5 Y 5/2 d); silty clay loam; moderate to strong, fine to medium, granular; friable, sticky; plentiful, very fine and fine horizontal roots; clear, broken boundary 0-15 cm thick; neutral.
BCky	Very dark greyish brown (10 YR 3/2 m), dark greyish brown (2.5 Y 4/2 d); silty clay loam; moderate, medium subangular blocky; friable, sticky; few, fine, random roots; weakly calcareous; grandual, broken boundary; 0-16 cm thick; neutral.
Cky	Very dark greyish brown (10 YR 3/2 m), dark greyish brown (2.5 Y 4/2 d); silt loam; weak to moderate, medium, subangular blocky; friable, sticky; moderately calcareous; abrupt, broken boundary; 0-20 cm thick; neutral.
Ckz	Dark greyish brown (2.5 Y 4/2 d); silt loam; moderately calcareous; 40-60 cm thick; neutral; 60-90% visible ice.
IICkz	Dark greyish brown (2.5 Y 4/2 d); sand; weakly calcareous; mildly alkaline; 35% visible ice seen as occasional ice lenses up to 5 cm thick.

Table 1b. Analytical data for an Orthic Turbic Cryosol (site 314)

Chemical Properties

Horizon	% $CaCO_3$ equiv	pH ($CaCl_2$)	% C (organic)	% N	Sodium Pyrophosphate %Fe	Sodium Pyrophosphate %Al	Exchangeable Cations 2N NaCl me/100g Ca	Mg	K	Conductivity mS/cm
Ahy	1.1	7.2	9.3	0.7	0.12	0.04	-	-	-	0.4
Bmy1	1.4	7.3	3.6	0.3	0.12	0.03	-	-	-	0.2
Bmy2	2.5	7.1	5.7	0.4	0.23	0.03	-	-	-	0.2
BCky	4.5	7.2	4.8	0.3	0.24	0.03	-	-	-	0.3
Cky	5.9	7.2	4.5	0.3	0.25	0.03	-	-	-	0.3
Ckz	9.1	7.3	4.1	0.2	0.38	0.04	-	-	-	1.0
IICkz										

Physical Properties

Horizon	Textural Class	% Sand	% Silt	% Clay
Ahy	silty clay loam	9.8	54.7	35.5
Bmy1	silty clay loam	6.4	53.8	39.8
Bmy2	silty clay loam	13.7	52.2	34.1
BCky	silty clay loam	18.6	51.4	29.9
Cky	clay loam	22.2	49.3	28.5
Ckz	silt loam	24.3	52.1	23.6
IICkz	sand	-	-	-

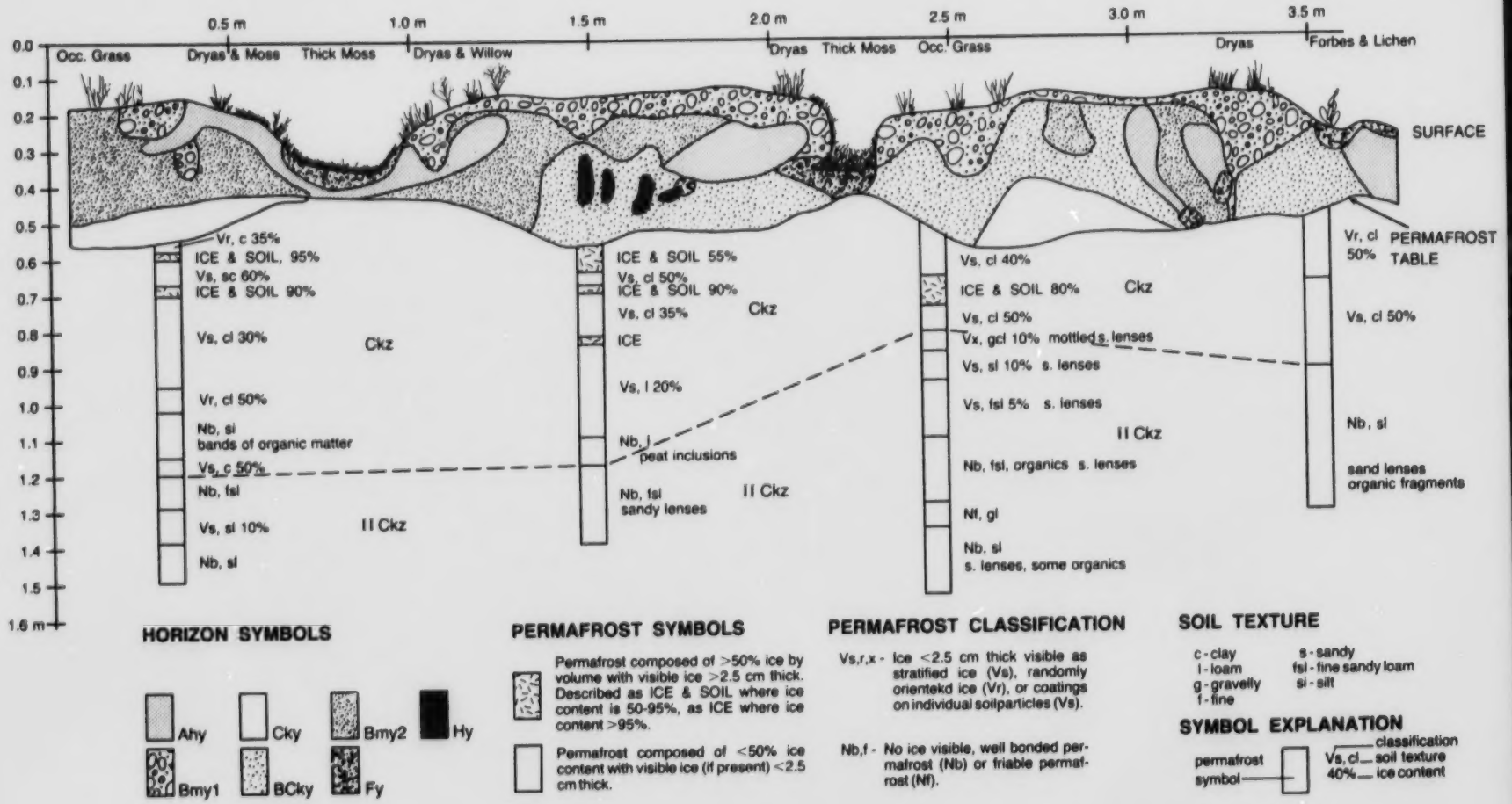

Figure 8. Cross-section of an Orthic Turbic Cryosol and drill logs of near-surface permafrost. See profile description in Table 1a. This profile was examined under non-sorted stripes and shows evidence of extensive cryoturbation.

and may have active layers up to 30 cm thick. The near-surface permafrost is often dominated by ice masses and the permafrost table undulates strongly 15-40 cm below the soil surface. On stable uplands, the uppermost mineral soil tends to be acidic with pH often less than 5.0 and in extreme cases less than 4.0. Some of these Orthic Turbic Cryosols of the stable (non-eroding) upland can have appreciable sesquioxide content (see profile description for site 323, Appendix 1). Carbonates are leached from the active layer and strong expressions of granular and columnar structure exist in these horizons.

In depressional landscape positions associated with ice wedge polygons, Gleysolic Turbic Cryosols occur where the soils remain saturated throughout the year (Table 2). The Turbic Cryosols of Herschel Island are characterized by micro-hummocky surface form and in some instances by non-sorted patterned ground. In areas of imperfect to poor drainage, surface hummocks may be accentuated by the cover of tussock vegetation. Fox (1979) described oxidation/reduction processes results in distinct mottling and gleying as characteristic of this subgroup.

Brunisolic Turbic Cryosols were rarely observed in the study area. They are confined to mature pedons with relatively inactive cryoturbation in the upland region of the island.

On gentle slopes where soils have been subject to recent mass movement as well as cryoturbation, little horizon development is evident and Regosolic Turbic Cryosols are the norm. The effects of chemical weathering are minimal in these soils. They may lack the strong soil structures that are observed in many of the subsurface horizons of Orthic Turbic Cryosols. The uppermost mineral horizon usually exhibits the granular strucutre that is very characteristic of the fine-textured soils on Herschel Island.

2.3.2 Static Cryosols

These soils are most common where either mass movement or deposition has recently disrupted the process of soil formation and left surface material largely unaffected by cryoturbation. These soils are classified as Regosolic Static Cryosols. On sloping ground, thaw slides remove the active layer and associated organic debris, expose the permafrost to thermal degradation and initiate the formation of a new active layer. These soils lack the surface earth-hummocks and cryoturbated horizons common in the Turbic Cryosols.

Static Cryosols are also found in association with the alluvial fans and channel fills found throughout the island (Table 3). In these cases, the soil is formed within recently transported

Site 2a. Site and pedon description for a Gleysolic Turbic Cryosol associated with ice wedge polygons.

SITE DESCRIPTION:

Site No:	316
Unit Name:	Guillemot
Location:	69° 55'N, 139° 05'W
Elevation:	155 m asl
Slope:	0% (depressional)
Drainage:	Poor
Active layer thickness:	45 cm
Vegetation:	Sedge-Grass
Parent Material:	Clayey Marine
Soil Classification:	Gleysolic Turbic Cryosol, fine clayey, mixed, strongly calcareous, exteremely cold, aquic.
Representativeness:	This pedon was described on an upland depressional site in association with ice wedge polygons and non-sorted cicrles. The lower solum remains saturated all year. The upper solum is slightly acid while the parent material is calcareous indicating some weathering has taken place in this soil.

PEDON DESCRIPTION:

Horizon	Depth (cm)	Description
Omy	0-10	Black (10 YR 2/1 m), very dark greyish brown (10 YR 3/2 d); very friable, nonsticky; plentiful, very fine and random roots; abrupt, broken boundary; 0-15cm thick; slightly acid.
Ahy	10-15	Very dark brown (10 YR 2/2 m), very dark greyish brown (10 YR 2/2 d); silty clay loam; very weak, fine to medium; granular; very fine and fine, random roots; abrupt, broken boundary; 0-17 cm thick; slightly acid.
Bmkgjy	15-20	Very dark greyish brown (10 YR 3/2 m), olive grey (5 Y 5/2 d); silty clay to silty clay loam; very weak, fine to medium, subangular blocky; friable, slightly sticky; few, fine and random roots; gradual, broken boundary; 0-17 cm thick; neutral.
Ckg1	20-27	Dark greyish brown (2.5 Y 4/2 m), olive grey (5 Y 5/2 d); silty clay loam; moderate, medium, granular; hard, sticky; mildly calcareous; clear, broken boundary; 0-5 cm thick; mildly alkaline.
Ckg2	27-45	Dark grey (5 Y 4/1 m), olive grey (5 Y 4/1 d); silty clay loam; massive; firm, sticky; mildly calcareous; abrupt, broken boundary; 0-40 cm thick; mildly alkaline.
Ckz	45+	Olive grey (5 Y 5/2 d); silt clay loam, moderately calcareous; 60-70% visible ice; mildly alkaline.

Table 2b. Analytical Data for a Gleysolic Turbic Cryosol (site 316)

Chemical Properties

Horizon	% $CaCO_3$ equiv	pH ($CaCl_2$)	% C (organic)	% N	Sodium Pyrophosphate %Fe	Sodium Pyrophosphate %Al	Exchangeable Cations 2 N NaCl me/100g Ca	Mg	K	Conductivity mS/cm
Omy	-	6.2	19.3	1.09	-	-	36.5	10.9	1.06	-
Ahy	-	6.3	16.5	0.90	0.30	0.08	45.7	8.88	1.05	0.22
Bmkgjy	-	6.9	3.75	0.30	0.21	0.02	22.6	4.64	1.05	0.36
Ckgy1	7.9	7.6	2.98	0.24	0.10	0.01	-	-	-	0.24
Ckgy2	7.7	7.5	2.59	0.22	0.06	0.01	-	-	-	0.25
Ckz	13.8	7.8	2.54	0.12	0.33	0.01	-	-	-	0.29

Physical Properties

Horizon	Textural Class	% Sand	% Silt	% Clay
Omy	Organic	-	-	-
Ahy	silty clay loan	8.8	51.8	39.4
Bmkgjy	silty clay loan	7.2	52.8	40.0
Ckgy1	silty clay loan	6.7	55.1	38.2
Ckgy2	silty clay loan	7.5	56.0	36.5
Ckz	silty clay loan	10.2	61.4	28.3

Table 3a. Site and pedon description for a Gleysolic Static Cryosol formed on an active fluvial fan.

SITE DESCRIPTION:

Site No:	234
Unit Name:	Orca
Location:	69° 34'N, 138° 54'W
Elevation:	4 m asl
Slope:	3%, smooth
Drainage:	imperfectly - poorly
Active layer thickness:	31 cm
Vegetation:	Willow/Saxifrage-Coltsfoot
Parent Material:	fine loamy fluvial fan
Soil Classification:	Gleysolic Static Cryosol, fine loamy, mixed, weakly calcareous
Representativeness:	This pedon was described on an active alluvial fan. Although the soils are saturated most of the year, mottling is weak. This is considered to be a function of extremely cold soil temperatures and oxygenated seepage waters.

PEDON DESCRIPTION

Horizon	Depth (cm)	Description
Ck	0-14	Dark grey/olive grey (5Y 4.5/1 m); silty clay loam; moderate, fine to medium subangular blocky; slightly sticky, friable, slightly plastic; plentiful, fine and horizontal roots; gradual, smooth boundary; moderately calcareous; mildly alkaline; 13-15 cm thick; mildly alkaline.
Ckgj1	14-31	Dark grey (5Y 4/1 m); silt loam; weak to moderate, medium to coarse, subangular blocky; nonsticky, very friable, slightly plastic; plentiful, fine and random roots; few, fine, faint mottles; grandual, smooth boundary; moderately calcareous, mildly alkaline; 16-17 cm thick, mildly alkaline.
Ckgj2	31-51	Dark grey (5Y 4/1m); silty clay loam; weak to moderate, medium subangular blocky; slightly sticky, friable, slightly plastic; few, fine vertical roots; few fine, faint mottles, abrupt, smooth boundary; moderately calcareous; 18-20 cm thick, mildly alkaline.
Ckz	31+	Clay to silty clay loam; massive; mildly alkaline; weakly calcareous, visible ice.

Table 3b Analytical data for a Gleysolic Static Cryosol (site 234)

Chemical Properties

Horizon	% $CaCO_3$ equiv	pH ($CaCl_2$)	% C (organic)	% N	Sodium Pyrophosphate %Fe	%Al	Exchangeable Cations 2 N NaCl me/100g Ca	Mg	K	Conductivity mS/cm
Ck	7.6	7.6	3.00	0.30	0.10	0.01	-	-	-	0.28
Ckgj1	9.4	7.4	3.23	0.26	0.09	0.01	-	-	-	0.23
Ckgj2	5.7	7.4	3.89	0.37	0.14	0.02	-	-	-	0.38
Ckz	2.5	7.5	3.54	0.35	0.19	0.02	-	-	-	0.45

Physical Properties

Horizon	Textural Class	% sand	% silt	% clay
Ck	silty clay loam	2.2	66.9	30.9
Ckgj1	silty loam	22.1	61.7	16.1
Ckgj2	silty clay loam	8.1	56.0	35.9
Ckz	silty clay/clay	0.9	40.7	58.4

material unaffected by cryoturbation. Depending on the amount of material deposited and time since deposition, the active layer may initially be >50 cm thick. As the soil matures the relatively deep and smooth permafrost table rises within the soil control section to eventually undulate 15-40 cm below the soil surface. When Static Cryosols are associated with fresh materials or recently disturbed surfaces, they are almost always calcareous and have massive structure. They may be considered as soils that represent features of early soil cryogenesis and if undisturbed will, with time, assume the characteristics of Turbic Cryosols.

The beaches on Herschel Island are underlain by permafrost 50 to 150 cm below the soil surface, depending on the exposure and the nature of the water table. These soils are composed of sands and gravels and as such are not subject to the same frost churning mechanisms that affect the fine-textured upland soils. The lack of well defined horizons results in these soils being classified as Regosolic Static Cryosols where permafrost is less than 100 cm below the surface.

2.3.3 Other Soils

Rarely, soils are not underlain near surface by permafrost nor are they affected by cryoturbation. In these cases the soils are classified as either belonging to the Regosol or the Brunisol order depending upon the degree of weathering and horizon formation. These conditions can be found on backshore beach deposits, some eolian landforms and the gravel outcrops found on the S.W. portion of the island. Some sites affected by faunal activity (Smits et al., 1988) have been classified as Regosols.

Soils formed largely of organic parent materials occur on Herschel Island but are not widespread. In association with ice-wedge polygons, peat accumulation occurs. Occasionally surface peat accumulations can be >40 cm thick. The peat tends to be poorly decomposed. Peat deposits are also observed on palsas in which masses of ice exist within the soil control section. These soils are classified as Glacic Organic Cryosols or simply Fibric Organic Cryosols, depending on whether or not ice masses are present.

3. VEGETATION SURVEY METHODS AND CLASSIFICATION

3.1 Methods of survey

Prior to field surveying, aerial photographs were examined stereoscopically for an overview of the island's geomorphology and the relationship between landform and vegetation cover. Polygons of homogeneous vegetation were incorporated into the delineation of ecological map units.

The majority of sampling sites were selected in conjunction with the soil survey crew, on representative landscapes where vegetation and soil surveying were conducted simultaneously. A number of additional vegetation plots were sampled without the collection of soil data. In total, data were analyzed from 125 vegetation plots.

Single sample plots (relévés) were situated within homogeneous vegetation stands. In map units characterized by vegetation complexes, an attempt was made to sample contrasting homogeneous stands in close proximity to one another.

Generally, plots were circular and measured approximately 20 metres in diameter. Plots of varying dimension but of equal area occasionally were necessary due to the irregular shape of the homogeneous vegetation cover (e.g. ice wedges, palsas, animal dens and perches).

Within each plot, the canopy of ground cover of each species in each strata or layer was estimated to the nearest 5.0 percent. At the low end of the cover scale, species present with an estimated 1.0 percent canopy cover were recorded as such; species present with less than 1.0 percent cover (i.e. trace occurrences) were all recorded as 0.1 percent.

Vegetation was categorized into the following strata: Medium Shrub - woody plants >0.5 to 1.5 m high; Low Shrub - woody plants 0.1 to 0.5 m high; Ground Shrub - woody plants less than 0.1 m high; Graminoid - grasses, sedges, rushes; Forb - all forbs regardless of height; Bryophyte - mosses and liverworts; Lichen - terrestrial lichens; Other - algae, fungus.

Percent cover of vegetative litter, slash (i.e. litter >1.0 cm diameter), rock, surface water and bare ground were also recorded. The ecological moisture regime was described in a range from very xeric to hydric (Walmsley et al, 1980). Photographs were taken of each site.

Nomenclature for vascular plants primarily follows Porsild and Cody (1980) and secondarily Hultén (1968); for mosses, Ireland et al (1980); for hepatics, Conrad and Redfern (1979); and for

lichens, Hale (1979). Voucher specimens are deposited in the herbaria of the Government of Yukon, Department of Renewable Resources, Whitehorse; the Biosystematics Research Centre, Agriculture Canada; and the National Museum of Natural Sciences, Ottawa. A list of plant species recorded in the course of this study comprises Appendix 3.

3.2 Vegetation Classification

The vegetation was grouped into 11 classes called "vegetation types" (v.t.), based primarily on the dominance of species in each strata. Dominance was determined by cover values, thereby giving the classification system a quantitative character. Species presence received consideration in terms of indicator or diagnostic species, for purposes of vegetation description.

The plot data for each vegetation type was summarized by tabular comparison. The species structure (i.e. percent cover of each species by strata) of each vegetation type is presented in Appendix B.

The vegetation types were named to reflect their physiognomic structure by strata. The dominant physiognomic feature of a strata was generally, but not necessarily, the dominant species as determined by percent cover. As the names are of a descriptive nature, not all strata are represented for every vegetation type. In the name, a slash (/) separates strata, and a hyphen (-) separates species within the same strata.

3.3 Vegetation Type Descriptions

A brief description is given for each vegetation type, including its distribution, composition and successional status. Site and cover values are included where possible, as either a range of observed values or as a mean. Vegetation types are also summarized on the legend accompanying the 1:25,000 ecological terrain map of Herschel Island. Tables showing representative species distribution values for each vegetation type are presented in Appendix 2.

3.3.1 COTTONGRASS/MOSS
Eriophorum vaginatum/Bryophytes

Site Characteristics and Distribution

The Cottongrass/Moss vegetation type is widespread on level to gently sloping, subhygric to mesic sites. The associated soils are imperfectly drained Orthic Turbic Cryosols. This type is established on the vast upland areas of the island where permafrost lies relatively close to the surface.

Sorted circles or mud boils are generally present, although

sparse. This type also comprises part of the vegetation complex that establishes on polygonal ground where cottongrass tussocks dominate the centres of raised polygons which are surrounded by ice wedges or drainage channels.

Vegetation Description

Sedge tussocks, comprised of Eriophorum vaginatum (10-20% cover) are the outstanding feature of this type, commonly referred to as "tussock tundra" (Wiken et al. 1981). Occasionally Carex lugens, another tussock-forming sedge, replaces E. vaginatum.

The tussocks vary from 10-50 cm in height and grow 20-60 cm apart. A sparse layer of low shrubs (5-10%) establishes between the tussocks, dominated by Salix spp. (S. reticulata, S.arctica, S.pulchra). Ericaceous shrubs (Cassiope tetragona, Vaccinium vitis-idaea, Vaccinium uliginosum, Ledum decumbens, Ledum groenlandicum) comprise a scant cover (1-5%) but are more prevalent in this v.t. than in any other. Dryas integrifolia occurs with variable cover (0-35%). Other forbs are diverse, but of infrequent occurrence (.1-1% cover) (eg. Polygonum bistorta, Pedicularis capitata, Senecio lindstroemii, Saxifraga punctata, Papaver spp., Sausserea angustifolia, Stellaria monantha and Valeriana capitata).

A well-developed moss layer (20-70% cover) is typical; the occurrence of Sphagnum is sporadic, with cover ranging from 0-5%. This is the only vegetation type where Sphagnum was recorded. Lichens (Cetraria cucullata, Cetraria islandica, Thamnolia subuliformis, Dactylina artica, Alectoria ochroleuca) are ubiquitous in trace amounts. Exposed mineral soil (usually non-sorted circles) covers 1 to 5% of the ground surface.

Successional Status

The Cottongrass/Moss v.t. is very stable and is probably the climax vegetation on most sites where it is established. It may develop from wet graminoid meadows (Sedge-Grass v.t.) if the drainage improves, or, conversely if there is a rise in the permafrost table (Viereck et al. 1986).

3.3.2 ARCTIC WILLOW/DRYAS-VETCH
Salix arctica/Dryas-Astragalus

Site Characteristics and Distribution

The Arctic Willow/Dryas-Vetch v.t. occurs extensively on mesic sites on gently undulating upland slopes. The associated soils are dominantly moderately well drained Orthic Turbic Cryosols. This type is most frequently associated with non-sorted patterned ground where exposed soil is a prominent feature. It establishes to a lesser extent on mesic sites on moderately eroded terrain;

occasionally it colonizes the raised centres of ice wedge polygons.

Vegetation Description

The vegetation cover is discontinuous, characterized by circular patches of bare mineral soil (up to 80% cover) surrounded by dense mats of Dryas integrifolia (5-60%) and bryophytes (5-50%). On these vegetated areas, Salix arctica is the dominant shrub (mean 10%); a low percent cover (mean 4%) of Salix reticulata is typical, but other shrubs are scant (e.g. Cassiope tetragona) Arctostaphylos alpina appears to be of unusual occurrence on the island, recorded only in this v.t. in trace amounts. A diversity of forb species with low cover but high frequency include Astragalus umbellatus, A. alpinus, Lupinus arcticus, Parrya nudicaulis, Myosotis alpestris, Pedicularis capitata, and Senecio lindstroemii. A scant cover of lichen (e.g. Cetraria cucullata, Thamnolia subuliformis, Alectoria ochroleuca) is ubiquitous (.1%-5%).

Successional Status

Although little is known regarding the dynamics of succession in this type, it is probably relatively stable. The upland sites where it establishes are often exposed and soil drainage is not impeded. This type is usually the climax vegetation on the sites where it occurs.

3.3.3 WILLOW/SAXIFRAGE-COLTSFOOT
Salix/Saxifraga-Petasites

Site Characteristics and Distribution

The Willow/Saxifrage-Coltsfoot v.t. occurs on gentle slopes on moderately well to imperfectly drained Turbic Cryosols. The permafrost table lies at variable depth below the surface. The vegetation generally forms a continuous cover and establishes most commonly on moderately eroded terrain. It frequently occurs on seepage sites at the foot of slopes and valley bottoms, as well as fluvial fans.

Vegetation Description

A low shrub cover of Salix spp. is a prominent feature of this vegetation. Salix arctica (mean cover 15%) dominates the sites, with S. reticulata a frequent co-dominant. The ground cover is typically a well-developed moss carpet (mean 50%); very little bare ground is present, though shrub leaf litter is considerable (mean 14%). Lichen is absent or scarce. Forbs are low in percent cover but frequent and notably diverse: Astragalus umbellatus, Polygonum viviparum, Saxifraga hirculus, Senecio

spp., and Petasites spp. Both Dryas integrifolia and Equisetum spp. occur with highly variable cover values (0-55%). Graminoids are absent or sparse (0-10%).

Successional Status

On upland sites, this vegetation type often occurs adjacent to moderately eroded areas where the Arctic Willow/Lupine-Lousewort v.t. is established. The proximity of these types in conjunction with their floristic elements suggests that the Willow/Saxifrage-Coltsfoot v.t. evolves from the Arctic Willow/Lupine-Lousewort v.t. as erosion subsides.

The continued deposition of fine grained material and the presence of seepage maintains this type in a relatively unstable state where slumping is a common event.

3.3.4 SEDGE-GRASS
Carex-Gramineae

Site Characteristics and Distribution

The Sedge-Grass vegetation type occurs on level to very gently sloping sites under hygric conditions. The soils are dominantly imperfectly to very poorly drained Static or Organic Cryosols. Standing water may be present and the permafrost table lies <50 cm below the surface. This type establishes on fluvial fans and also comprises part of the vegetation complex of polygonal ground where it colonizes the ice wedge drainage channels between the raised polygons.

Vegetation Description

Sedge-Grass v.t. is a graminoid herbaceous meadow vegetation, typically dominated by Carex aquatilis (15-50% cover). Occasionally grasses (e.g. Dupontia fisheri, Alopecurus alpinus) or other sedges (Carex rariflora, Eriophorum angustifolium) may dominate or co-dominate the site. Shrub cover of Salix spp. is variable (0-20%), relative to the moisture regime; Salix tend to be lacking on the very wettest and driest sites and are most prevalent on interim sites. Forbs are low in percent cover but high in frequency and diversity (Pedicularis spp., Saxifraga hirculus, S. cernua, Petasites spp., Equisetum spp., Valeriana capitata, Ranunculus spp., Polemonium spp., Rumex spp.) Mosses are common and usually high in cover (10-80%); Sphagnum is unrecorded. Lichens are absent or rare. Graminoid leaf litter comprises considerable ground cover (15-70%). Standing water represents 5-50% cover in drainage channels of polygonal ground and may be seasonally present on other sites in early summer.

Successional Status

This type represents a fairly broad ecological range and encompasses several related vegetation communities. The drier, grass-sedge meadows with abundant forbs are relatively stable, maintained by seepage and deposition of fine grained fluvial material. The wetter sedge-dominated meadows may develop into grass-sedge meadows, or sedge tussocks if there is a drop in the water table (Viereck et al, 1986). Should the water table rise, the graminoid meadows may develop into a marsh vegetation, similar to that described for the Sedge/Mare's Tail-Marsh Marigold v.t.

3.3.5 ARCTIC WILLOW/LUPINE-LOUSEWORT
Salix arctica/*Lupinus*-*Pedicularis*

Site Characteristics and Distribution

The Arctic Willow/Lupine-Lousewort v.t. is established on mesic sites characterized by irregularly mounded surfaces on gently to strongly sloping terrain. This vegetation cover is associated with earth hummocks 25-50 cm in diameter and spaced 20-70 cm apart. Soils are moderately well to imperfectly drained Turbic Cryosols with a depth to permafrost of <50 cm. This type is of limited distribution, occurring in moderately eroded areas. Many occurrences are situated on accumulations of earth debris near the foot of slopes and in creek gullies.

Vegetation Description

The Arctic Willow/Lupine-Lousewort v.t. is characterized by a well- developed layer of prostrate willows (25-50%) dominated by *Salix arctica* (15-50%); *S. reticulata* is present with variable cover (1-20%). The forb layer is exceptionally robust and diverse, superceded only by the vegetation of faunal features such as fox dens and bird perches. Most of the forb biomass is established on the earth hummocks, dominated by *Dryas integrifolia* (10-35%) and *Lupinus arcticus* (10-15%). An array of colourful herbs includes: *Myosotis alpestris*, *Pedicularis capitata*, *Astragalus umbellatus*, *Valeriana capitata*, *Castilleja elegans*, *Saxifraga hieracifolia* and *Ranunculus turneri*. Graminoids (e.g. *Carex rupestris*, *Luzula nivalis*) are sparse (0-5%).

Moss cover (30-65%) is most prevalent in the depressions between the hummocks, which are otherwise sparsely colonized. Lichens (e.g. *Cetraria cucullata*, *Thamnolia subuliformis*, *Peltigera* spp.) are scattered throughout, with a variable cover value (0.1-15%). Shrub leaf litter comprises 10-20%. The percent cover of non-vegetated ground is generally minimal (1%) except on sites of recent slumping.

Successional Status

The Arctic Willow/Lupine-Lousewort v.t. is established on terrain that is relatively steep and unstable; the slopes are in the process of slumping or eroding and with it, the vegetation is evolving. As rough surfaces are smoothed out, there are fewer micro-habitats for species and diversity decreases. This type likely succeeds to the Willow/Saxifrage-Coltsfoot v.t. which frequently occurs on less active areas. Alternatively, through the deposition of masses of mineral soil, the Arctic Willow/ Lupine-Lousewort v.t. can become inundated and the early successional vegetation types such as Grass/ Chamomile-Wormwood or Sorrel-Coltsfoot-Wormwood may establish.

3.3.6 GRASS/CHAMOMILE-WORMWOOD
Gramineae/Matricaria-Artemisia

Site Characteristics and Distribution

The Grass/Chamomile-Wormwood v.t. is established under mesic conditions on recently disturbed sites. Slopes vary from gentle to steep; all are characterized by a high percentage (up to 50%) of exposed soil. Moderately well-drained Static Cryosols are most common. The permafrost table lies at considerable depth (i.e. >50 cm). This vegetation develops on sites of extensive soil deposition such as the area downslope from retrogressive thaw flowslides and on earth slumps in major ravines undergoing severe erosion.

Vegetation Description

The Grass/Chamomile-Wormwood v.t. is dominated by Gramineae spp. (7-58%) including Alopecurus alpinus, Arctagrostis latifolia, Trisetum spicatum and Puccinellia spp.; Carex spp. generally occur in scant amounts (0.1-1%). The shrub layer is low in diversity, dominated by Salix arctica (5-15%). Forbs vary in cover from sparse to extensive (1-23%); the most prominent species are Matricaria ambigua, Artemisia tilessii, Senecio congestus, Petasites spp., Myosotis alpestris, Castilleja elegans and Pedicularis sudetica. Non-vegetated ground is a predominant feature (25-75%), hosting bryophytes (5-30%) in surface fissures. Lichens are rare. Graminoid litter may be considerable.

Successional Status

The Grass/Chamomile-Wormwood v.t. is an early successional v.t., maintained by the frequent deposition of fine-grained material. Floristic elements of this type originate from divergent sources: wind-borne propagules of typical pioneer species (e.g. Cruciferae and Matricaria) and strongly nitropholous grasses such as Alopecurus; and remnants of mature vegetation (e.g. Salix arctica

which have sloughed off the adjacent terrain) frequently combine to colonize the site. As stabilization occurs, steep gully slopes likely evolve into the Arctic Willow/Lupine-Lousewort v.t. while gentle slopes of former mudflows develop into the Willow/Saxifrage-Coltsfoot v.t.

3.3.7 WILD RYE/SAXIFRAGE-PRIMROSE
Elymus/Saxifraga-Primula

Site Characteristics and Distribution

The Wild Rye/Saxifrage-Primrose v.t. occurs on mesic sites near the coastline, typically on fans and spits. Soils are rapidly to imperfectly drained Cryosols and less commonly, Regosols and Brunisols. The permafrost table is relatively deep, lying >50 cm below the surface. These sites are established a few metres above sea level on marine sands and gravels.

Vegetation Description

The Wild Rye/Saxifrage-Primrose v.t. is dominated by graminoids (10-55% total cover) and forbs of high frequency but low percent cover (0.1-15% total). The most predominant graminoid is Elymus arenaria; other major species include Puccinellia spp. and Alopecurus spp.. The diverse forb strata typically includes Matricaria ambigua, Primula borealis, Stellaria spp., Saxifraga cernua, Minuartia spp., Pedicularis spp., Senecio spp., and Cruciferae spp..

Shrubs are sparse, Salix arctica is the most commonly occurring (0-15% cover). Moss comprises 15-50% of the ground cover. A small proportion of ground is non-vegetated; cover of graminoid litter can be considerable (10-50%). Lichen is absent.

Successional Status

As sediment accumulates along shorelines, beach sites become elevated and removed from active wave action. This vegetation type most likely develops with species enriching the Wild Rye/Sandwort-Lungwort v.t. as stability increases over time. Elymus communities may also gradually replace halophytic herb communities (Sedge/Chickweed) as beach progradation decreases the frequency of tidal inundation (Viereck et al, 1986). Vegetation composition on major fluvial fans on the island indicates that the Wild Rye/Saxifrage-Primrose v.t. may be replaced by the Sedge-Grass v.t. or the Willow/Saxifrage-Coltsfoot v.t. over time.

3.3.8 SEDGE/CHICKWEED
Carex/Stellaria

Site Characteristics and Distribution

The Sedge/Chickweed v.t. occupies depressions and the margins of brackish lagoons situated on marine spits and beaches. These hygric to subhygric sites are frequently subjected to inundation by tidal water, as well as exposure to harsh winds and erosion by ice. The underlying substrate is comprised of clays and silts, in contrast to the adjacent raised areas where sands and gravels predominate. Soils are imperfectly to very poorly drained Cryosols; the permafrost table is relatively deep (>50 cm) below the surface. This vegetation type may establish on materials slightly above or below sea level.

Vegetation Description

The Sedge/Chickweed v.t. is a halophytic community of sedges and forbs characterized by low species diversity. Vegetation cover ranges from scant clumps to continuous turf (0.1-95% total cover), often consisting of a monoculture of Carex subspathacea. Other important graminoids include Carex glareosa, C. ursina, C. amblyorhyncha and Puccinellia vaginata. With the exception of Stellaria humifosa (0-35% cover), forbs are extremely limited in cover and frequency. Moss cover is variable (0-20%). Algae is often present (0-20%) in association with a high water table. Lichen is absent. On well-vegetated sites graminoid litter is extensive and there is little bare ground; on sparsely colonized sites, the converse is true.

Successional Status

The Sedge/Chickweed v.t. is a pioneer association which persists under poorly drained, brackish conditions. A drier moisture regime may evolve through deposition of sediment on spits and fans; sites subsequently become less frequently inundated by saltwater and the water table drops. As mesic conditions arise, species diversity and cover increase, eventually developing into the Wild Rye/Saxifrage-Primrose v.t.

3.3.9 WILD RYE/SANDWORT-LUNGWORT
Elymus/Honckenya-Mertensia

Site Characteristics and Distribution

The Wild Rye/Sandwort-Lungwort vegetation type occurs on mesic to subxeric sites on sandy marine spits and beaches. Although exposed to wind and ice, these sites are elevated above high tide. The coarse-grained soils are rapidly to well drained Regosols. The permafrost table is situated at 100 to 116 cm, the

greatest depth recorded on the island. This type is very limited in distribution, occurring only on marine landforms at elevations just slightly above sea level.

Vegetation Description

The Wild Rye/Sandwort-Lungwort v.t. is very sparsely vegetated (.1-15% total cover) and characterized by low species diversity. Elymus arenarius is the most common species, establishing in patches comprising .1-10% cover. Mertensia martima and Honckenya peploides are important floristic elements, occurring in scattered clumps (.1-15%) A few herbs (Minuartia spp.), and graminoids (Puccinellia spp.) occur in trace amounts (0-0.1%). Mosses are absent or rare. Non-vegetated sand is a predominant groundcover feature (50-90%), typically overlain by large driftwood (5-50%).

Successional Status

Wild Rye/Sandwort-Lungwort is the first community to pioneer well-drained sites on marine beaches. Colonization may be hampered due to severe erosion by storms and ice movement. Species diversity and cover increase as stabilization of sites proceeds through the deposition and uplift of materials. Over time, this type evolves into Wild Rye/Saxifrage-Primrose.

3.3.10 SEDGE/MARE'S TAIL-MARSH MARIGOLD Carex/Hippuris-Caltha

Site Characteristics and Distribution

This vegetation type occupies marshy habitats situated on coastal spits and fans, as well as drainage channels and depressions throughout the island's interior. These level sites have a hydric to subhydric moisture regime; the water table lies at or near the surface, with standing water comprising a significant proportion of surface area. Soils are very poorly drained Gleysolic Static Cryosols and Organic Cryosols. Sedge/Mare's Tail-Marsh Marigold occurs in association with brackish water on fans and beaches, as well as in ice wedge channels and pothole lakes associated with polygonal landforms.

Vegetation Description

The Sedge/Mare's Tail-Marsh Marigold v.t. is characterized by a closed, marginated vegetation cover which grades into non-vegetated water surfaces. Hippuris is the diagnostic species of this type (5-50% cover), rooting in fresh water (H.vulgaris) or brackish water (H.tetraphylla). Hippuris is noted as one of the few truly aquatic vascular plants in the Arctic (Prescott, 1980; Wiggens and Thomas, 1962). Dense stands of marsh grasses (5-15% cover) such as Arctophila fulva and Dupontia fisheri

extend from shore into the water. Carex aquatilis, Arctagrostis latifolia and Eriophorum angustifolium grow on less saturated ground. Forbs are species-poor and sparse (0-0.1%); those of most frequent occurrence are Caltha palustris, Ranunculus spp., Saxifraga spp., and Minuartia spp.. Low shrubs (e.g. Salix arctica and S. reticulata) occur sporadically. Moss cover is continuous (20-80%) over non-aquatic surfaces. Graminoid litter accounts for 5-40% cover. Lichen is absent.

Successional Status

A change toward a drier moisture regime can result from the aggradation of spits and fans, or from the draining of ice wedge channels in polygonal ground. Subsequent vegetation succession would proceed toward a cover of sedge, grass, forbs and willows (e.g. Sedge-Grass v.t.). In later stages of succession on spits and fans, this vegetation may evolve into the Wild Rye/Saxifrage-Primrose v.t. or the Willow/Saxifrage-Coltsfoot v.t. In the long-term succession associated with the erosion of polygonal ground, ice wedge channels are likely invaded by the species from the adjacent polygons which formerly supported the Cottongrass/Moss or Arctic Willow/Dryas-Vetch vegetation types.

3.3.11 SORREL-COLTSFOOT-WORMWOOD
Oxyria-Petasites-Artemisia

Site Characteristics and Distribution

The Sorrel-Coltsfoot-Wormwood v.t. is comprised of chinopholous plants, which colonize areas where snow persists into late summer. These snow patch communities typically establish in very localized situations in shady, steep-sided ravines and creek confluences. Seepage is present and a subhydric moisture regime prevails. Soils are imperfectly drained Cryosols. There is a steady deposition of fine-grained material transported by snow meltwater.

Vegetation Description

The Sorrel-Coltsfoot-Wormwood v.t. is a forb-dominated community of early successional species (20-60% total forb cover). Petasites spp., Oxyria digyna, Artemisia arctica, Myosotis alpestris and Ranunculus spp. are the most common and widespread herbs, each with a cover comprising up to 20%. Achillea millefolium, Saxifraga spp., Minuartia spp. and Cruciferae spp. are frequent colonizers with low cover values (0-1%). Total graminoid cover ranges from 10-12% and includes Poa arctica, Alopecurus spp., Calamagrostis spp. and Trisetum spicatum. Low Salix spp. may be present (0-5%). The moss layer is usually well developed (0-25%); lichens are absent. A significant proportion of the ground is unvegetated (20-75%).

Successional Status

This v.t. is maintained in an early successional state by the frequent deposition of soil material. If slopes stabilize (e.g. through erosion) this type most likely develops into a Willow/Saxifrage-Coltsfoot v.t. or an Arctic Willow/Lupine-Lousewort hummocky vegetation. The moisture regime will likely remain mesic to submesic in the next successional stage.

4. ECOLOGICAL INTEGRATIONS OF SOIL AND VEGETATION TYPES

4.1 Design of the Map and Legend

Previous ecological inventory in the northern Yukon identified Herschel Island within the Northern Coastal Plain Ecoregion (Oswald and Senyk, 1977). Subsequent, more detailed studies, established Herschel Island as one of six ecodistricts within that ecoregion (Wicken et al., 1981). This present inventory, at still larger scale, describes eight ecological map units for Herschel Island that approximate the ecosite level of detail as described by Wicken (1980).

The map legend was designed to describe holistic, repeating, ecological map units. Each map unit is designed to encompass many landscape features in an easily remembered name and symbol. The map uses a controlled legend (i.e. only eight map unit names are defined) and a simple map polygon descriptor - only slope and moisture regime vary independently. The names used for each map unit are based on local landmarks or fauna and in themselves act only as labels to identify unique sets of ecological conditions. This approach allows the transfer of knowledge from one familiar area to an unfamiliar but similarly labelled area elsewhere on the map. Map polygons (delineations) are designed to correspond to changes recognizable on the ground. Soil and vegetation characteristics for each map unit are described on the map legend and in somewhat more detail in this section of the report.

4.2 Interpretative Materials

Perceived park management concerns associated with each map unit are briefly discussed. Interpretive ratings for various park activities are presented in a table on the perimeter of the 1:25,000 ecological map of the island. At the time of conducting the inventory, the scope of permitted land uses was not established nor was it possible to make observations on impacts of recreation activities within this low arctic environment. The interpretations that are based on our best estimates of future activities and the ecological response to these.

A separate report and map (1:25,000) on the interpretive methodology to establish capability ratings for map units to provide arctic fox denning habitat has been prepared by Smits et al (1987).

4.3 Description of Map Units

The following are summaries of the soil, vegetation and management considerations for each of the eight map units. Information about the range of ecological conditions for each is presented in narrative format for each unit. Representative site and pedon descriptions with accompanying analytical data are presented in Appendix 1.

4.3.1 Avadlek Map Unit

This map unit covers all contemporary marine landforms found along the margin of Herschel Island. The unit occupies 1% of the total study area or approximately 400 ha. A detailed description of the landforms within this unit is given on the 1:2,000 map of the Herschel settlement area. These landforms are principally beaches, spits and lagoons (Figure 9). Each has a distinctive soil texture range, moisture regime and vegetation cover. A summary of the range of ecological conditions found within this map unit is presented in Table 4.

Soils

The Avadlek unit is the only map unit where the permafrost table is occasionally at greater than one meter depth. As such, this unit contains most of the non-Cryosolic soils on the island. These are mainly Regosols and rarely Brunisols. Other soils belong to the Static Cryosol great group. Backshore beaches are above high tide level, composed of sands and gravel, rapidly drained and seldom show any horizon development. Spits may be inundated by storms, icebergs and high tides and may have both a water and permafrost table near the surface. Lagoons are composed of finer materials (generally fine sands) and are often inundated a high tide. These areas are characterized by Gleysolic Static Cryosols.

Vegetation

The vegetation types of the Avadlek unit do not occur elsewhere on the island. Most commonly the Wild Rye/Saxifrage-Primrose type is found on the dry beach materials above high tide (Figure 10). At slightly lower elevation on coarse marine landforms the Wild Rye/Sandwood-Lungwort type occurs. The Sedge/Chickweed type occupies depressions and the margins of brackish lagoons. This is a pioneer type which exists under high moisture conditions.

Management Considerations

The coarse texture of materials and the general lack of vegetation cover make this unit resistant to disturbance and suitable for most recreational activities; it provides well drained conditions for building placement (i.e. Herschel Settlement), although care must be taken to avoid active landforms when locating permanent structures. The Avadlek unit tends to be a geomorphically dynamic unit characterized by both rapid aggradation in some places and rapid removal in others.

4.3.2 Guillemot Map Unit

This map unit covers areas of active ice-wedge formation found in

Figure 9. Herschel Settlement is located on a cuspate spit (a gravelly marine landform) within the Avadlek Map Unit. A large fluvial fan (Orca Map Unit) is located behind the spit in the middle distance. Eroded terrain and the upland plateau are visible in the background.

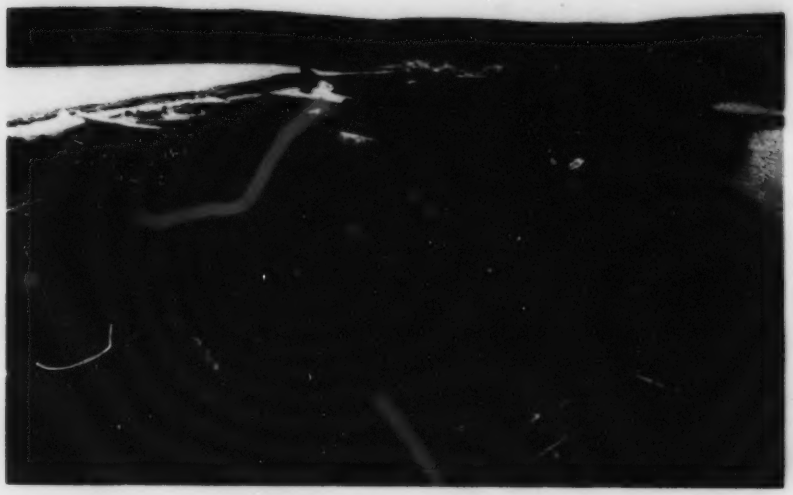

Figure 10. Wild Rye/Sandwort-Lungwort vegetation type found on well to rapidly drained marine gravel supporting the only non-cryosolic soils on the island. The driftwood on the beach originates from the Mackenzie River approximately 200 km east of Herschel Island.

Table 4 Ecological features associated with Avadlek Map Unit.

TERRAIN FEATURES		SOIL DEVELOPMENT		VEGETATION TYPES	
Map Unit:	Avadlek (Av)				
Topography:	Spits and beaches	**Exposed soil %:**	mean 9 range 0-90	**Dominant:**	Wild Rye/Sandwort-Lungwort
Gully Erosion:	marine erosion and deposition	**Active layer cm:**	mean 90 range 50-116	**Minor:**	Wild Rye/Saxifage-Primrose Sedge/Chickweed
Slope %:	mean 2 range 0-1	**Dominant soil:**	Regosolic Static Cryosol		
Patterned Ground:	rare ice wedge wedge polygons	**Minor soil:**	Gleysolic Static Cryosol Orthic Regosol		

Table 5 Ecological features associated with the Guillemot Map Unit.

TERRAIN FEATURES		SOIL DEVELOPMENT		VEGETATION TYPES	
Map Unit:	Guillemot				
Topography:	depressional polygonal ground	**Exposed soil %:**	mean 1 range 0-5	**Dominant:**	Cottongrass/Moss
Gully Erosion:	none	**Active layer cm:**	mean 23 range 13-35	**Minor:**	Sedge-Grass Sedge/Mare's Tail-Marsh Marigold
Slope %:	mean 3 range 0-6	**Dominant soil:**	Gleysolic Turbic Cryosol		
Patterned Ground:	low and high centre ice wedge polygons	**Minor soil:**	Fibric Organic Cryosol Orthic Turbic Cryosol		

level to depressional polygonal ground. Map delineations of Guillemot are usually small in size and limited in extent (4% of the study area or approximately 1600 ha.) and occur principally in the upland portion of the island in association with Herschel map unit (Figure 11). The Guillemot map unit is wet, with standing water associated with ice-wedge polygons and small thermokarst ponds. Both low and high centre polygons have been observed in this unit (Figure 12). These are associated with a succession of polygonal ground features common to the region. Contrasting ecological moisture regimes occur over short distances. A variety of soil and vegetation types result. The range of ecological conditions found within the unit is given in the map legend and presented in Table 5.

Soils

Soil drainage is generally poor to very poor with occasional imperfect drainage described for high centre polygons. Channels formed on top of ice wedges routinely have standing water. A common soil is Fibric Organic Cryosol in which greater than 40 cm of peat overlie mineral soil. As drainage improves, Gleysolic Turbic Cryosol and Orthic Turbic Cryosol are more common, and are similar to the soils of the Herschel map unit. Guillemot soils are acidic with pH values from 4.6 to 6.0.

Vegetation

The distribution of vegetation is linked to the ecological moisture regime. On portions of the unit that do not have standing water (i.e. polygon centres) the Cottongrass/Moss vegetation type predominates. On the very wettest portions of the unit, the Sedge-Grass vegetation type occurs. This type is found on hygric moisture regimes and is associated with the accumulation of peat. Standing water supports the Sedge/Mare's Tail - Marsh Marigold vegetation type. Occasionally polygon centres are colonized by the Arctic Willow/Dryas-Vetch vegetation type.

Management Considerations

The Guillemot map unit occurs in small pockets within larger areas of Herschel unit. Areas classified as Guillemot are wet and difficult to traverse on foot. While the formation of ice-wedge polygons is of ecological interest, polygonal ground is a common feature over much of the low lying area of the Beaufort Coast. Polygonal ground is best viewed from a distance. Any development should be directed away from this map unit. The terrain is very thaw sensitive and disturbance would lead to increased amounts of ponded water.

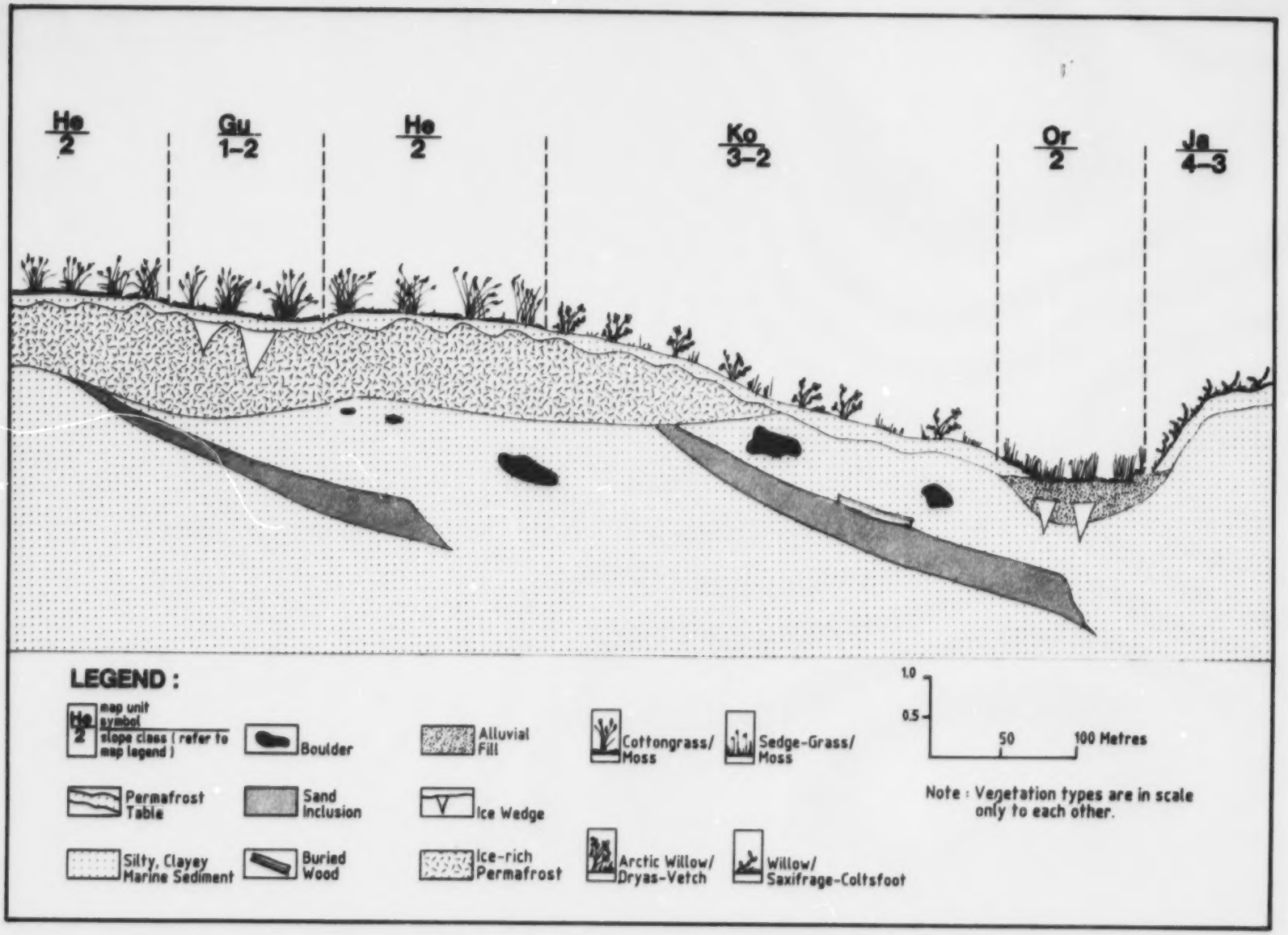

Figure 11. A schematic cross-section of the upland region of Herschel Island. The Komakuk Map Unit occurs on gently sloping terrain and is transitional between the relatively level Herschel Unit and the eroded Jaeger Unit.

Figure 12. Low-center polygons are common within the Guillemot Map Unit.

Figure 13. The Herschel Map Unit is uniformly dominated by vegetation belonging to the Cottongrass/Moss type. The level upland of the island is characterized by an expanse of "tussock" tundra.

4.3.3 Herschel Map Unit

The Herschel map unit covers approximately 15% (6000 ha.) of the study area and encompasses the expanse of upland plateau on the central portion of the island. It is characterized by gentle slopes seldom exceeding 5% and a microhummocky surface covered by the Cottongrass/Moss vegetation type. Ecological conditions are relatively uniform within polygons belonging to the Herschel map unit. Ecological conditions of the unit are summarized in Table 6.

Soil

This map unit covers stable upland surfaces where little erosion or mass movement has occurred. The dense vegetation cover promotes a shallow active layer. The permafrost table undulates beneath the surface at 5 to 35 cm depth. The soils are fine textured (clay to silty clay loam), imperfectly to poorly drained and remain moist throughout the year. The most common soil is Orthic Turbic Cryosol. Where the soils remain saturated for most the the year, Gleysolic Turbic Cryosols predominate. Within the active layer the soils are weathered. They are non-calcareous and acidic in reaction. Values of pH may be as low as 4.5. The soils contain variable amount of organic matter incorporated into the active layer through cryoturbation.

Vegetation

The map unit is characterized by uniform vegetation cover of the Cottongrass/Moss type (Figure 13). No other vegetation type occurs in any significant proportion on this map unit. This vegetation type is considered the climax upland vegetation community of the island. The cover of tussocks (Eriophorum vaginatum) makes this type memorable to anyone who has walked any distance through the map unit.

Management Considerations

The climax nature of the vegetation type and the degree of soil weathering illustrate the considerable ecological stability of the Herschel map unit. Disturbance to the ground surface will affect this long established equilibrium. Disturbances may be expressed as long-term vegetative scars, increases in the active layer thickness, and release of moisture from thawed permafrost with resultant water ponding on the surface.

The unit will withstand minor amounts of dispersed foot traffic although the vegetation cover and soil moisture conditions provide unpleasant hiking conditions. The shallow active layer and high ice content of near-surface permafrost make the unit thaw-sensitive. The level nature of the unit limits the hazard

Table 6 Ecological features associated with the Herschel Map Unit.

TERRAIN FEATURES		SOIL DEVELOPMENT		VEGETATION TYPES	
Map Unit:	Herschel (He)				
Topography:	Smooth uplands	**Exposed Soil %:**	mean 5 range 0-15	**Dominant:**	Cottongrass/Moss
Gully Erosion:	none	**Active layer cm:**	mean 20 range 5-36	**Minor:**	N/A
Slope %:	mean 1 range 0-7	**Dominant soil:**	Orthic Turbic Cryosol		
Patterned Ground:	occasional circles	**Minor soil:**	Gleysolic Turbic Cryosol		

Table 7 Ecological features associated with the Jaeger Map Unit.

TERRAIN FEATURES		SOIL DEVELOPMENT		VEGETATION TYPES	
Map Unit:	Jaeger				
Topography:	sloping, gullied terrain	**Exposed soil %:**	mean 12 range 0-50	**Dominant:**	Willow/Saxifrage-Coltsfoot
Gully Erosion:	moderate	**Active layer cm:**	mean 46 range 16-90	**Minor:**	Arctic Willow/Dryas-Vetch Arctic Willow/Lupine-Lousewort Grass/Chamomile-Wormwood
Slope %:	mean 11 range 4-33	**Dominant soil:**	Regosolic Static Cryosol		
Patterned Ground:	earth hummocks, non-sorted nets and circles	**Minor soil:**	Orthic Turbic Cryosol Gleysolic Static Cryosol		

of erosion.

4.3.4 Jaeger Map Unit

This map unit covers approximately 8000 ha and is comprised of lands that are undergoing moderate erosion. The Jaeger map unit is transitional between the level upland units (Herschel and Komakuk) and the gullied Thrasher unit (Figure 14). The erosion produces a complex slope providing a range of ecological niches, each with its own set of characteristics (Figure 15). Slopes vary over short distances and have a range of between 4 and 33%. Earth hummocks and non-sorted patterned ground are common. A summary of the ecological conditions associated with this map unit is given in the map legend and presented in Table 7.

Soils

Erosion and mass movement are integral processes active within this map unit. Soil moisture conditions are variable and effect the distribution of vegetation types. Mass movement (solifluction) and erosion expose fresh parent material, cause temporary disruption to the permafrost table and interrupt soil forming processes. As a result, a common soil of this map unit is the Regosolic Static Cryosol in which well developed horizons are lacking. Cryoturbation is active but is only evident in the soil profile on more stable sites. A considerable range in the percentage of exposed soil (due principally to mass movement processes) and the depth to permafrost exists at sites within this unit. Active layers average 46 cm in thickness and soils are alkaline with pH values from 7.0 to 7.8. Soils are often calcareous to the surface.

Vegetation

The dominant vegetation type within the Jaeger map unit is Arctic Willow/Saxifrage-Coltsfoot which occurs on moist eroded soils. Arctic Willow/Dryas-Vetch predominates on gentle slopes and non-eroded soils. Arctic Willow/Lupine-Lousewort is found on steeper slopes dominated by earth hummocks. On sites where recent fresh parent material has been deposited the Grass/ Chamomile-Wormwood type occurs.

Management Considerations

This map unit provides a varied visual landscape, relatively favourable hiking conditions and some degree of protection from wind while traveling. The unit provides opportunities for viewing birds and small mammals which favour the habitat provided by this unit. Permanent trails could be subject to slumping. Disturbance of exposed soil areas could lead to accelerated erosion.

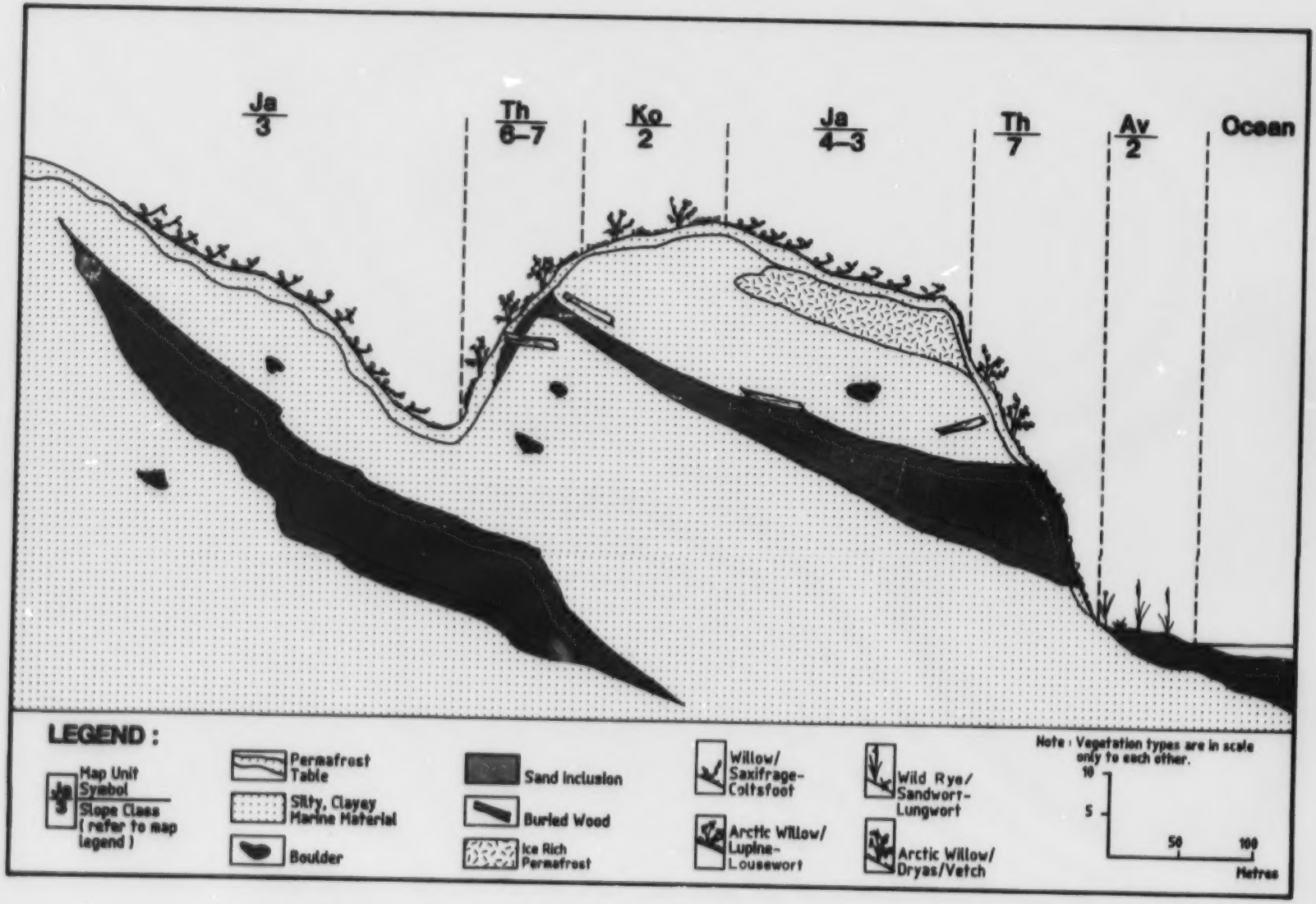

Figure 14. A schematic cross section of the eroded terrain of Herschel Island. The sand inclusions, boulders and massive ice are intended to illustrate the heterogeneous nature of the soil parent materials.

Figure 15. The Jaeger Map Unit supporting Arctic Willow/Lupine-Lousewort is shown in the left foreground, the more strongly eroded terrain to the right is representative of the Thrasher Map Unit.

Figure 16. Non-sorted patterned ground with extensive amounts of exposed soil are characteristic of the Plover Map Unit. A Komakuk landscape can be seen in the background. The dominant vegetation type in the photo is Arctic Willow/Dryas-Vetch.

4.3.5 Komakuk Map Unit

This is the most common map unit on Herschel Island covering almost half (44%, 17,600 ha) of the study area. The unit is characterized by extensive, smooth uplands with mean slope value of 7%. The unit exhibits more variation in both soil and vegetation conditions than the Herschel unit. Erosion is only slight and evidence of gullying is minor. Variation in slope position and shape affect the amount of water available to plant communities within the unit. A summary of ecological conditions of this map unit are summarized in the map legend and presented in Table 8. A schematic cross-section showing the relationship of the Komakuk map unit with other upland map units is illustrated in Figure 11.

Soil

The soils of the Komakuk map unit are generally fine-textured and moderately well to imperfectly drained. Where soils are moderately well drained on convex slopes and crests, the active layer is from 40 to 50 cm thick. Imperfectly drained soils on concave slopes and level terrain have active layers between 15 and 25 cm thick. The most common soil is Orthic Turbic Cryosol. Non-sorted patterned ground is common and 15 to 20% of the soil surface is typically unvegetated. Where cryoturbation is most intense and recognizable weathered horizons are lacking, Regosolic Turbic Cryosols occur. Komakuk soils tend to be slightly acidic to neutral (pH values range from 5.5 to 7.2) depending on the degree of mixing within the soil.

Vegetation

The dominant vegetation type within this map unit is Arctic Willow/Dryas-Vetch associated with moderately well drained soils on gentle slopes. In areas where drainage is imperfect, the Cottongrass/Moss type predominates.

Management Considerations

This map unit is generally drier and the permafrost table deeper than the associated Herschel map unit. The tussock vegetation (Cottongrass/Moss) is restricted in its distribution to concave and level surfaces. Generally the Arctic Willow/Dryas Vetch vegetation is well suited to hiking and foot travel. The Komakuk unit will sustain considerable foot traffic although unsurfaced trails would quickly show wear and perhaps erosion. The terrain is relatively less sensitive to disturbance and permafrost thaw than others on the island. Mass movement and erosion are not significant hazards.

Table 8 Ecological features associated with the Komakuk Map Unit.

TERRAIN FEATURES		SOIL DEVELOPMENT		VEGETATION TYPES	
Map Unit:	Komakuk (Ko)				
Topography:	sloping uplands	**Exposed Soil %:**	mean 16 range 0-60	**Dominant:**	Arctic Willow/Dryas-Vetch
Gully Erosion:	slight	**Active layer cm:**	mean 30 range 13-70	**Minor:**	Cottongrass/Moss
Slope %:	mean 7 range 0-11	**Dominant soil:**	Orthic Turbic Cryosol		
Patterned Ground:	earth hummocks, non-sorted nets and circles	**Minor soil:**	Regosolic Turbic Cryosol		

Table 9 Ecological features associated with the Orca Map Unit.

TERRAIN FEATURES		SOIL DEVELOPMENT		VEGETATION TYPES	
Map Unit:	Orca				
Topography:	alluvial fans	**Exposed soil %:**	mean 5 range 0-50	**Dominant:**	Sedge-Grass
Gully Erosion:	deositional	**Active layer cm:**	mean 45 range 10-75	**Minor:**	Willow/Saxifrage-Coltsfoot Wild Rye/Saxifage-Primrose Sedge/Mare's Tail-Marsh
Marigold					
Slope %:	mean 3 range 1-8	**Dominant soil:**	Regosolic Static Cryosol		
Patterned Ground:	occasional ice wedge polygons	**Minor soil:**	Gleysolic Turbic Cryosol		

4.3.6 Orca Map Unit

Associated with the transport of sediment on Herschel Island are a few large alluvial fans (Figure 9) and numerous smaller channel fill landforms. These make up 1% of the study area or approximately 400 ha. The Orca map unit covers all forms of alluvium on the island. For the most part this alluvium is gently sloping (1 to 8%) with occasional flowing water on the soil surface. Soil and vegetation characteristics of the unit reflect the influence of this high moisture environment. The range of ecological conditions found in this unit are given in the map legend and presented in Table 9.

Soils

The most common soil in the Orca map unit is Regosolic Static Cryosol. This unit is characterized by active deposition which periodically provides fresh material to the soil surface. Soils of this unit lack the micro-hummocky surface form that is common on most fine-textured soils on the island. Soil textures are generally silt clay loam to fine sand and only in major stream channels is any gravel found. These soils are often calcareous to the surface and pH values range from 6.5 to 7.5. Where the water table remains high, Gleysolic Static and Turbic Cryosols predominate. Only rarely, even under active stream channels, is the permafrost table at greater than one meter in depth.

Vegetation

This map unit is characterized by the Sedge-Grass vegetation type. Some portions of larger fans exhibit the relatively tall willows of Willow/Saxifrage-Coltsfoot and areas of standing water are characterized by Sedge/Mare's Tail-Marsh Marigold as is observed within the Guillemot unit.

Management Consideration

The Orca unit has level, smooth surfaces that are moist and occasionally wet. The two large fans on the island that belong to the Orca map unit provide access from the coastline to the interior of the island. The fan behind Herschel settlement at Pauline cove has been used for a variety of purposes. The whalers and Eskimo graveyards are highlights of any visit to the island (Figure 10). The high moisture content and susceptibility to frost heaving make this unit only marginally suitable for buildings and permanent structures.

The upland portion of the unit provides good hiking conditions and is relatively resistant to disturbance by foot traffic. The wetland portion is significant at Pauline cove. Walking is difficult and soils are sensitive to hiking disturbance. Boardwalks should be considered for this area due to its

intensive use and the susceptibility of bird nesting sites to disruption.

4.3.7 Plover Map Unit

This map unit is limited in extent, covering only 3% of the study area. Polygons described as Plover occur frequently but are generally less than 10 ha in size. The Plover map unit is characterized by extensive areas (generally greater than 40%) of exposed soils as the result of active patterned ground processes. Non-sorted nets and stripes are most common (Figure 16). This condition can be found throughout the island on convex slopes and ridge crests on gently sloping topography, characteristically in small patches. Where the unit is not extensive enough to be delineated separately on the 1:25,000 ecological map, this unit exists as an inclusion within the Komakuk or Jaeger units. A summary of the ecological conditions associated with the Plover map unit are given in the map legend and presented in Table 10.

Soils

The soils of the Plover map unit exhibit some of the most active cryoturbation to be found in the study area. The dominant soil is Orthic Turbic Cryosol. An example of a profile described under non-sorted stripes is given in Table 1 and illustrated schematically in Figure 8. Where non-sorted nets occur and distinct Bmy horizons are lacking, then Regosolic Turbic Cryosols predominate. The permafrost table undulates in association with non-vegetated patterned ground forms. The depth to permafrost may be up to 65 cm or as little as 20 cm under vegetated troughs within the patterned ground network. Depending on the degree of mixing, surface soils may or may not be calcareous and pH values range from 6.0 to 7.2. Organic matter and humus-rich mineral soil may be incorporated as broken soil horizons (Ahy and Hy) throughout the active layer. The best developed patterned networks are observed on fine-texture sediments.

Vegetation

Only one vegetation type, Willow/*Dryas*-Vetch occurs in the map unit. It is distributed as stringers of vegetation between non-sorted patterned ground forms. Where the amount of exposed soil is limited, the distribution of Willow/*Dryas*-Vetch is like that on the Komakuk landscapes.

Management Considerations

The areas designated as Plover map unit exhibit unique soil and vegetation features. The extensive presence of patterned ground is an ecological feature of interest. Because there is little vegetation cover, the sites are extremely sensitive to disturbance even from foot traffic except during the driest

Table 10 Ecological features associated with the Plover Map Unit.

TERRAIN FEATURES		SOIL DEVELOPMENT		VEGETATION TYPES	
Map Unit:	Plover (Pl)				
Topography:	convex slopes and ridges	**Exposed Soils %:**	mean 47 range 15-65	**Dominant:**	Arctic Willow/Dryas-Vetch
Gully Erosion:	slight	**Active layer cm:**	mean 40 range 30-65	**Minor:**	N/A
Slope %:	mean 9 range 4-25	**Dominant soil:**	Regosolic Turbic Cryosol		
Patterned Ground:	extensive non-sorted nets and circles	**Minor soil:**	Orthic Turbic Cryosol		

Table 11 Ecological features associated with the Thrasher Map Unit.

TERRAIN FEATURES		SOIL DEVELOPMENT		VEGETATION TYPES	
Map Unit:	Thrasher (Th)				
Topography:	strongly gullied terrain, active failing	**Exposed Soil %:**	mean 19 range 0-70	**Dominant:**	Arctic Willow/Lupine-Lousewort
Gully Erosion:	severe	**Active layer cm:**	mean 55 range 35-78	**Minor:**	Grass/Chamomile-Wormwood Sorrel-Coltsfoot-Wormwood
Slope %:	mean 27 range 22-50	**Dominant soil:**	Regosolic Static Cryosol		
Patterned Ground:	disrupted earth hummocks	**Minor soil:**	Orthic Turbic Cryosol Orthic Static Cryosol		

periods of summer. The relatively smooth, bare surfaces of the non-sorted forms provide attractive hiking conditions. As the Plover unit is often located on ridge crests, these sites can have pleasant vistas of the island and surrounding marine shoreline.

4.3.8 Thrasher Map Unit

The Thrasher map unit covers areas of steep gully and mass movement erosion. It has been mapped over 13% (5200 ha) of the study area. The map unit contains a range of landform, soil and vegetation conditions associated with this eroded terrain. Slopes at sample site locations ranged from 20-50%, however coastal bluffs which are also included in this map unit may be nearly vertical. These slopes are extremely unstable. Solifluction, retrogressive thaw flowslides and debris slides are all common. A summary of the ecological conditions of the Thrasher unit is given in the map legend and presented in Table 11.

Soil

Thrasher soils have relatively deep active layers, generally greater than 50 cm and often between 60 to 80 cm on recent failure scars. As slope processes are a dominant soil-forming factor, the effects of cryoturbation and horizonation are often not evident. The most common soil of this unit is Regosolic Static Cryosol. The soil surface is often dominated by remnants of earth hummocks which can remain loosely intact while moving downslope. The constant exposure of unweathered parent material results in an alkaline soil, usually calcareous to the surface with pH ranging from 7.2 to 7.8. Soils are well and moderately well drained. Depending on the stability of the slope, Orthic Turbic and Orthic Static Cryosols are of minor occurrence.

Vegetation

The most common vegetation type within the Thrasher map unit is Arctic Willow/Lupine-Lousewort. This is the vegetation cover associated with earth hummock mounds occurring on moderately sloping (up to 25%) terrain. Because of the complex nature of Thrasher slopes, this one vegetation type does not have widespread occurrence but rather occupies more stable localized microsites. In areas of more recent disturbance or on freshly exposed surfaces the early successional Grass/Chamomile-Wormwood type is found. The Thrasher unit contains erosional features that are utilized by birds for nesting and perches and by foxes for denning. In these localized areas faunal alteration of the site leads to nutrient enrichment and the development of a floristically rich vegetation type unlike any of the the more widespread communities described.

Management Condiserations

Extreme slope instability dictates that any developments, either temporary or permanent, avoid the use of the Thrasher unit. The presence of bird nesting and fox den sites is of ecological interest. Disturbances from occasional hiking will be minor in comparison to disturbances resulting from the natural erosion processes within the unit.

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APPENDIX 1

The following are complete site and pedon descriptions with analytical data for representative soils asssociated with each map unit. Examples of soils from the Guillemot and Orca map units are presented in Tables 2 and 3 of this report.

For soils that are strongly affected by cryoturbation (Turbic Cryosols) the traditional listing of horizon depth is omitted. Broken horizons simply do not lend themselves to meaningful vertical profile measurements. The thickness range for each horizon is given in the description of each horizon within the pedon.

Abbreviated descriptions are included for the uppermost horizon below the permafrost table. The completeness of the description was dependant on our ability to observe permafrost materials at the time of sampling.

SITE DESCRIPTION: Komakuk Type Site

Site No:	237
Unit Name:	Komakuk
Location:	69° 34'N, 138° 56'W
Elevation:	75 m asl
Slope:	6%
Drainage:	Moderately well drained
Active layer thickness:	40 cm
Vegetation:	Arctic willow/Dryas-Vetch
Parent Material:	Glacier ice-thrust clayey mixed marine sediments
Soil Classification:	Orthic Turbic Cryosol
Representativeness:	This is a mature profile exhibiting strong cryotorbation and leached solum. Note that the permafrost table incorporates organic matter and weathered soil material indicating that the active layer thickness has varied over time.

PEDON DESCRIPTION

Horizon	Description
Bmy1	Very dark greyish brown (10 YR 3/2 m); silty clay loam to silty clay; moderate, fine to medium, granular; slightly sticky, very friable, plastic; plentiful, medium, oblique, roots; clear, irregular boundary; 4-25 cm thick; medium acid.
Bmy2	Dark greyish brown (2.5 Y 4/2 m); silty clay loam; moderate, fine to medium, granular; slightly sticky, very friable, plastic; few, very fine, random roots; clear, broken boundary; 0-17 cm thick; slightly acid.
Ahy	Black (10 YR 2/1m); silty clay loam; weak, fine to medium, subangular blocky breaking to weak to moderate, fine to medium, granular structure; slightly sticky, very friable, plastic; very few, fine, random roots; 0-8 cm thick; neutral.
Bmyz	Very dark grayish brown (10 YR 3/2 m); clay loam; variable properties and ice content with common incorporated humus-rich materials.

Analytical Data for site 237

Chemical Properties

Horizon	% $CaCO_3$ equiv	pH ($CaCl_2$)	% C (organic)	% N	Sodium Pyrophosphate %Fe	Sodium Pyrophosphate %Al	Exchangeable Cations 2 N NaCl me/100g Ca	Mg	K	Conductivity mS/cm
Bmyl	-	5.9	5.5	0.4	0.35	0.10	23.0	6.32	0.98	0.3
Bmy2	-	6.2	4.6	0.4	0.26	0.09	23.8	5.92	0.92	0.2
Ahy	-	6.6	8.0	0.6	0.35	0.10	33.2	9.87	0.96	0.2

Physical Properties

Horizon	Textural Class	% Sand	% Silt	% Clay
Bmyl	silty clay loam	13.2	46.8	40.0
Bmy2	silty clay loam	13.5	50.0	36.5
Ahy	silty clay loam	11.9	52.0	36.1

SITE DESCRIPTION: Thrasher Type Site

Site No:	144
Unit Name:	Thrasher
Location:	69° 37'N, 139° 3'W
Elevation:	68 m asl
Slope:	32%
Drainage:	Moderately well drained
Active layer thickness:	35 cm
Vegetation:	Grass/Chamomile-Wormwood
Parent Material:	Clayey moraine
Soil Classification:	Orthic Turbic Cryosol
Representative:	This is a mature soil profile on collivual parent material. Note that the soil is largely non-calcareous and strongly cryoturbated. Soils more recently disturbed would likely be classified as Static Cryosols.

PEDON DESCRIPTION

Horizon	Description
Ahy	Very dark greyish brown (10 YR 3/2 m); clay loam; weak, fine, subangular blocky; nonsticky, very friable, slightly plastic; plentiful, very fine random roots; abrupt, broken boundary; 0-10 cm thick; neutral.
Bmy1	Dark greyish brown (10 YR 4/2 m); silt loam; weak, medium, angular blocky to weak, fine, angular blocky; slightly sticky, very friable; slightly plastic; plentiful, fine to medium random roots; clear, irregular boundary; 13-35 cm thick; neutral.
Bmy2	Dark yellowish brown (10 YR 4/4 m); loam to silty loam; weak to moderate, fine to medium, subangular blocky; slightly sticky, very friable; plastic; few, fine, oblique roots; abrupt, broken boundary; 0-13 cm thick; neutral.
Cky	Very dark greyish brown (2.5 Y 3/2 m); silty clay loam; weak to moderate, medium granular; sticky, friable, very plastic; clear, broken boundary, moderately calcareous; 0-9 cm thick; mildly alkaline.

Analytical Data for site 144

Chemical Properties

Horizon	% $CaCO_3$ equiv	pH ($CaCl_2$)	% C (organic)	% N	Sodium Pyrophosphate %Fe	Sodium Pyrophosphate %Al	Exchangeable Cations 2 N NaCl me/100g Ca	Exchangeable Cations 2 N NaCl me/100g Mg	Exchangeable Cations 2 N NaCl me/100g K	Conductivity mS/cm
Ahy	0.4	7.2	10.4	0.6	-	-	-	-	-	0.5
Bmy1	0.0	7.0	5.1	0.3	0.28	0.07	-	-	-	0.3
Bmy2	0.0	6.7	3.4	0.3	0.21	0.07	18.4	5.9	0.93	0.2
Cky	6.6	7.5	2.6	0.2	0.12	0.02	-	-	-	0.3

Physical Properties

Horizon	Textural Class	% Sand	% Silt	% Clay
Ahy	clay loam	22.3	47.3	30.4
Bmy1	silty loam	24.2	49.4	26.4
Bmy2	loam	26.9	48.1	25.1
Cky	silty clay loam	10.8	59.0	30.2

SITE DESCRIPTION: Avadlek Type Site

Site No:	224
Unit Name:	Avadlek
Location:	69° 34′, 139° 18′W
Elevation:	2 m asl.
Slope:	Level
Drainage:	Imperfectly
Active layer thickness:	110 cm
Vegetation:	Wild Rye/Sandwort-Lungwort
Parent Material:	Gravelly sandy marine
Soil Classification:	Orthic Eutric Brunisol

Representativeness: This pedon represents the soil development on the very large marine spit located on the southwest corner of Herschel Island. This is the only landform to support Brunisolic soils. Note than the Ah horizon is saline. The Bm horizon is a dark brown colour, contains appreciable organic carbon but shows no evidence of sesquioxide accumulation.

PEDON DESCRIPTION

Horizon	Depth (cm)	Description
Ah	0-6	Black (10 YR 2/1 m); sand; single grain; nonsticky, friable; nonplastic; plentiful, very fine to fine random roots; clear, smooth horizon boundary; 5-7 cm thick; neutral.
Bm	6-19	Very dark brown (10 YR 2/2 m); sand; very weak, fine to medium, subangular blocky; nonsticky, very friable, nonplastic; plentiful, fine, random roots; clear and wavy boundary; weakly calcareous; 10-15 cm thick; neutral.
BCk	19-31	Dark brown (10 YR 3/3 m); sand; structureless; single grain; nonsticky, loose, nonplastic; abrupt and smooth boundary; moderately calcareous; 10-20 cm thick; mildly alkaline.
Ck1	31-35	Olive brown (2.5 Y 4/4 m); sand; structureless, single grain; nonsticky, loose, nonplastic; abrupt, smooth boundary; 3-6 cm thick; mildly alkaline.
Ck2	35-110	Dark greyish brown (2.5 Y 4/2m); sand; structureless, single grain; nonstickly, loose, nonplastic; moderately calcareous; 50-60 cm thick; neutral.
Ckz	110+	

Analytical Data for site 224

Chemical Properties

Horizon	% $CaCO_3$ equiv	pH ($CaCl_2$)	% C (organic)	% N	Sodium Pyrophosphate %Fe	%Al	Exchangeable Cations 2 N NaCl me/100g Ca	Mg	K	Conductivity mS/cm
Ah	0.0	7.2	14.2	0.9	0.09	0.05	-	-	-	3.4
Bm	1.1	7.1	3.0	0.2	0.03	0.01	-	-	-	0.5
BCk	6.7	7.4	0.8	0.1	0.01	0.01	-	-	-	0.2
Ck1	6.1	7.3	0.8	0.0	0.01	0.01	-	-	-	0.3
Ck2	5.7	7.2	0.8	0.0	0.01	0.01	-	-	-	0.4

Physical Properties

Horizon	Textural Class	% Sand	% Silt	% Clay
Ah	sand	90.3	6.0	3.7
Bm	sand	94.6	3.2	2.3
BCk	sand	97.8	1.0	1.2
Ck1	sand	-	-	-
Ck2	sand	98.7	0.5	0.8

SITE DESCRIPTION: Jaegar Type Site - Turbic Phase

Site No:	145
Unit Name:	69° 36'N, 138° 58'W
Elevation:	90 m asl
Slope:	15%
Drainage:	Moderately well
Active layer thickness:	41 cm
Vegetation:	Arctic willow/Lupine-Lousewort
Parent Material:	Clayey colluvium
Soil Classification:	Orthic Turbic Cryosol
Representativeness:	This pedon is typical of an Orthic Turbic Cryosol formed on sloping topography on moderately eroded terrain. Horizon boundaries are irregular but not broken. There is a marked increase in $CaCO_3$ content with depth.

PEDON DESCRIPTION

Horizon	Description
F	Very dark grey (10 Y 3/1 m); abundant, fine vertical roots; gradual, smooth boundary; 2 cm thick.
Ahy	Very dark grey (10 YR 3/1 m); silty clay; weak, fine, granular; slighty sticky, plastic; plentiful, fine to medium, oblique roots; gradual, irregular boundary; 5-30 cm thick; neutral.
Bmy	Dark grey (10 YR 4/1 m); silty clay; weak to moderate, medium, blocky breaking to moderate to strong, fine, angular blocky; sticky, plastic; few, coarse, random, roots; gradual, irregular boundary; weakly calcareous; 5-18 cm thick; mildly alkaline.
Cky	Dark grey (10 YR 4/1 m); silty clay; moderate, fine to medium, angular blocky; sticky, plastic; few, sparse, random, roots; gradual, irregular boundary; moderately calcareous; 2-12 cm thick; mildly alkaline.

Analytical Data for site 145

Chemical Properties

Horizon	% $CaCO_3$ equiv	pH ($CaCl_2$)	% C (organic)	% N	Sodium Pyrophosphate %Fe	Sodium Pyrophosphate %Al	Exchangeable Cations 2 N KaCl me/100g Ca	Mg	K	Conductivity mS/cm
Ahy	0.0	7.1	9.1	0.7	0.20	0.02	-	-	-	0.6
Bay	3.6	7.5	2.5	0.2	0.12	0.01	-	-	-	0.3
Cky	6.8	7.8	1.9	0.1	0.07	0.01	-	-	-	0.4

Physical Properties

Horizon	Textural Class	% Sand	% Silt	% Clay
Ahy	silty clay	5.8	49.4	44.8
Bay	silty clay	3.1	47.9	49.0
Cky	silty clay	1.8	47.9	50.3

SITE DESCRIPTION: Herschel Type Site

Site No:	323
Unit Name:	Herschel
Location:	69° 36'N, 139° 00'W
Elevation:	128 m asl
Slope:	1%, simple
Drainage:	Imperfectly
Active layer thickness:	15 cm
Vegetation:	Cottongrass/Moss
Parent Material:	Glacier ice-thrust marine sediments
Soil Classification:	Orthic Turbic Cryosol
Representativeness:	This pedon is a mature soil described on the upland plateau. Note the very shallow active layer, the presence of ice in the permafrost and the leached conditions of the upper solum. Na-pyrophosphate extractable Fe and Al values exceed 1.0%.

PEDON DESCRIPTION

Horizon	Description
F	Yellowish brown (10 YR 5/6 m); partially decomposed sedges and moss; gradual, broken boundary; 6-9 cm thick; extremely acid.
Ahy	Dark greyish brown (10 YR 4/2 m); clay loam; weak, medium, subangular blocky; non-sticky, friable; random fine roots; clear, wavy boundary; 2-12cm thick; extremely acid.
Bmgy	Dark yellowish brown (10 YR 4/4 m), silty clay loam; weak to moderate, medium, subangular blocky; slightly sticky, friable; very few, fine, horizontal roots; abrupt, broken boundary; 0-8 cm thick; very strong acid.
BCz	Dark yellowish gray (10 YR 6/3 m); silty clay; non-calcareous, no visible ice
Wz	Frozen water as lense ice.

Analytical Data for site 323

Chemical Properties

Horizon	% $CaCO_3$ equiv	pH ($CaCl_2$)	% C (organic)	% N	Sodium Pyrophosphate %Fe	%Al	Exchangeable Cations 2 N NaCl me/100g Ca	Mg	K	Conductivity mS/cm
F	-	3.8	31.5	1.2	0.09	0.05	13.0	6.1	2.3	-
Ahy	-	4.4	14.0	0.9	1.37	0.24	18.9	6.5	1.0	0.6
Bagy	-	4.6	4.0	0.3	0.98	0.18	10.7	4.0	0.9	0.2

Physical Properties

Horizon	Textural Class	% Sand	% Silt	% Clay
F	organic	-	-	-
Ahy	clay loam	24.3	44.8	30.9
Bagy	silty clay loam	9.1	53.2	37.7

SITE DESCRIPTION: Jaegar Type Site - static phase

Site No:	324
Unit Name:	Plover
Location:	69° 35'N, 138° 55'N
Elevation:	30 m asl
Slope:	7% simple
Drainage:	Moderately well drained
Active layer thickness:	47 cm
Vegetation:	Arctic Willow/Lupine-Lousewort
Parent Material:	Clayey colluvium
Soil Classification:	Regosolic Static Cryosol
Representativeness:	This pedon is representative of soil profile development on disturbed material. Other than in the Ahy, there is a general lack of cryoturbation. Surface horizons tend to be only slightly more acidic that the underlying parent materials.

PEDON DESCRIPTION

Horizon	Depth (cm)	Description
Ahy	0-4	Dark brown (7.5 Y 3/2 m); silty clay loam; weak, medium, granular; nonsticky, loose, nonplastic; plentiful, very fine and random roots; clear, wavy boundary; 2-4 cm thick; neutral.
Bm	4-24	Very dark grey (10 YR 3/1 m); silty clay; very weak, fine to medium, granular; slightly sticky, very friable, slightly plastic; plentiful, very fine and random roots; gradual, wavy boundary; 20-28 cm thick; neutral.
Ck	24-27	Very dark grey (10 YR 3/1 m); silty clay loam; moderate, coarse, subangular blocky primary structure; breaking to moderate, medium, subangular blocky; nonsticky, loose, nonplastic; very few, fine and vertical roots; abrupt, smooth boundary; weakly calcareous; 2-5 cm thick; neutral.
Ckz	47+	Silty clay loam; weakly calcareous; mildly alkaline.

Analytical Data for site 324

Chemical Properties

Horizon	% $CaCO_3$ equiv	pH ($CaCl_2$)	% C (organic)	% N	Sodium Pyrophosphate %Fe	%Al	Exchangeable Cations 2 N NaCl me/100g Ca	Mg	K	Conductivity mS/cm
Ahy	-	6.7	11.9	0.9	0.19	0.05	39.1	12.8	1.4	-
Bm	-	6.6	4.2	0.4	0.19	0.05	20.9	5.2	1.3	0.3
Ck	3.9	7.3	2.8	0.2	0.14	0.03	-	-	0.3	-
Ckz	2.4	7.3	3.5	0.3	0.18	0.03	-	-	0.4	-

Physical Properties

Horizon	Textural Class	% Sand	% Silt	% Clay
Ahy	silty clay loam	13.5	51.1	35.3
Bm	silty clay	11.2	48.2	40.5
Ck	silty clay loam	14.6	50.0	35.4
Ckz	silty clay loam	16.4	48.1	35.5

SITE DESCRIPTION Komakuk Type Site

Site No:	238
Unit Name:	Komakuk
Location:	69° 36′N, 138° 56′W
Elevation:	68m asl
Slope:	5%, simple
Drainage:	Moderately well drained
Active layer thickness:	35 cm
Vegetation:	Arctic Willow/Dryas-Vetch
Parent Material:	Glacier ice-trust clayey marine sediments
Soil Classification:	Orthic Turbic Cryosol
Representativeness:	This pedon was described on gently sloping upland topography and is typical of the Orthic Turbic Cryosols formed on fine textured marine sediments. The effect of weathering on this mature soil profile is evident in lower pH of surface horizons.

PEDON DESCRIPTION:

Horizon	Description
Bm	Dark greyish brown (10 YR 4/2 m); silty clay; moderate to strong, medium, granular; slightly sticky, friable, slightly plastic; very few, medium, horizontal roots; clear, broken boundary; 0-6 cm thick; medium acid.
Bmy	Dark brown (10 YR 4/3 m); silty clay; moderate, medium, subangular blocky primary structure; moderate, medium, granular secondary structure; slightly sticky, friable, slightly plastic; plentiful, fine and medium, random roots; clear, broken boundary; 0-25 cm thick; medium acid.
Ahy	Very dark brown (10 YR 2/2 m); silty clay; weak to moderate, fine to medium, subangular blocky; nonsticky, very friable, slightly plastic; plentiful, fine and medium, random roots; abrupt, broken boundary; 0-14 cm thick; medium acid.
BCy	Very dark greyish brown (10 YR 3/2 m); silty clay; weak, medium, angular blocky; very few, fine, random roots; abrupt, wavy boundary; 0-25 cm thick; neutral.
Ckz	Silty clay loam; sticky, friable, plastic; moderately calcareous; mildly alkaline.

Analytical Data for a Orthic Turbic Cryosol (site 238)

Chemical Properties

Horizon	% $CaCO_3$ equiv	pH ($CaCl_2$)	% C (organic)	% N	Sodium Pyrophosphate %Fe	Sodium Pyrophosphate %Al	Exchangeable Cations 2 N NaCl me/100g Ca	Mg	K	Conductivity mS/cm
Bm	-	5.6	3.33	0.32	0.37	0.11	17.2	5.92	1.26	0.75
Bmy	-	5.9	3.36	0.29	0.37	0.11	17.9	6.71	1.07	0.18
Ahy	-	6.0	8.54	0.64	0.25	0.09	29.0	11.8	1.22	0.78
BCy	-	6.7	4.71	0.37	0.26	0.07	23.5	9.87	1.18	0.19
Ckz	8.0	8.1	2.05	0.19	0.10	0.02	-	-	-	1.23

Physical Properties

Horizon	Textural Class	% Sand	% Silt	% Clay
Bm	silty clay	3.8	49.7	46.5
Bmy	silty clay	4.5	50.7	44.8
Ahy	silty clay	9.7	48.2	42.1
BCy	silty clay	3.7	48.0	48.3
Ckz	silty clay loam	2.7	58.9	38.4

SITE DESCRIPTION: Plover Type

Site No:	315
Unit Name:	Plover
Location:	69° 35'N, 139° 05'W
Elevation:	158 m asl
Slope:	7%, convex
Drainage:	Moderately well drained
Active layer thickness:	40 cm
Vegetation:	Arctic Willow/Dryas-Vetch
Parent Material:	Glacier ice thrust clayey marine sediments
Soil Classification:	Orthic Turbic Cryosol
Representativeness:	This pedon was described under a non-sorted net undergoing intense cryoturbation. All horizons have broken boundaries. The increase in $CaCO_3$ equivalent value with depth is pronounced but the strongly weathered surface horizons such as found in the Herschel and Komakuk soils are absent. Note the strong granular structure of the Bmky and the strong prismatic structure on the Cky2.

PEDON DESCRIPTION

Horizon	Description
Ahky	Very dark greyish brown (10 YR 2/2 m), olive grey (5 Y 5/2 d); clay to silty clay; weak to moderate, very fine to fine subangular blocky; friable, sticky; weakly calcareous; abrupt, broken; 0-10 cm thick, mildly alkaline.
Bmky	Dark greyish brown (10 YR 3/2 m), olive grey (5 Y 5/2 d); moderate to strong, fine to medium granular; loose, sticky; few, very fine, random roots; weakly calcareous; clear, broken; 0-17 cm thick; mildly alkaline.
Cky1	Very dark greyish brown (10 YR 3/2 m), olive grey (5 Y 5/2 d); silty clay; weak to moderate, medium, subangular blocky; loose, friable, sticky; moderately calcareous; gradual, broken; 0-28 cm thick; mildly alkaline.
Cky2	Dark greyish brown (10 YR 3/2 m), olive grey (5 Y 5/2 d); silty clay; moderate to strong, medium, to coarse, prismatic; friable, sticky, moderately calcareous; gradual, broken boundary; 0-40 cm thick; mildly alkaline.
Ckz	Olive grey (5 Y 5/2 d); silty clay; weakly to moderately calcareous; mildly alkaline; Ice content 40% by volume.

Analytical Data for site 315

Chemical Properties

Horizon	% $CaCO_3$ equiv	pH ($CaCl_2$)	% C (organic)	% N	Sodium Pyrophosphate %Fe	%Al	Exchangeable Cations 2 N NaCl me/100g Ca	Mg	K	Conductivity mS/cm
Ahky	3.6	7.4	4.5	0.4	0.09	0.02	-	-	-	0.5
Bnky	4.6	7.6	2.2	0.2	0.07	0.02	-	-	-	0.3
Cky1	5.3	7.6	2.6	0.2	0.08	0.02	-	-	-	0.2
Cky2	5.8	7.5	2.6	0.3	0.08	0.02	-	-	-	0.2
Ckz	8.6	7.5	2.9	0.2	0.06	0.01	-	-	-	0.2

Physical Properties

Horizon	Textural Class	% Sand	% Silt	% Clay
Ahky	silty clay	5.4	43.3	51.3
Bnky	clay	2.9	37.2	59.9
Cky1	silty clay	4.0	49.2	46.8
Cky2	silty clay	3.1	48.8	48.2
Ckz	silty clay	3.8	51.2	45.0

APPENDIX 2

The following tables show representive species distribution in each vegetation type. Percent occurence is calculated as the number of times a species was observed within a respective type. Percent cover is caluclated as the mean cover value for each species based on the total number of plots within a repsective type. A value of trace (tr) is assigned when cover is less that 1%.

VEGETATION TYPE -COTTONGRASS/MOSS

		PERCENT OCCURRENCE	PERCENT COVER
SHRUBS:	Salix reticulata	80	7
	Salix spp.	100	1
	Cassiope tetragona	70	5
	Vaccinium vitis-idaea	55	5
	Salix arctica	45	1
	Salix pulchra	45	3
HERBS:	Polygonum bistorta	90	tr
	Pedicularis capitata	70	tr
	Senecio lindstromemii	95	tr
	Lagotis spp.		
	Saxifraga punctata	75	tr
	Dryas integrifolia	60	8
	Cruciferae spp.	45	tr
	Papaver spp.	55	tr
	Sausserea angustifolia	50	tr
	Saxifraga spp.	45	tr
	Stellaria monantha	45	tr
	Valeriana capitata	45	tr
	Pedicularis spp.	40	tr
GRAMINOIDS:	Eriophorum vaginatum	90	15
	Gramineae spp.	90	tr
	Carex spp.	60	tr
	Luzula nivalis	55	tr
MOSS:	Bryophyte spp.	95	40
LICHEN:	Cetraria cucullata	100	5
	Thamnolia subuliformis	100	1
	Cetraria islandica	75	1
	Dactylia artica	80	1
	Alectoria ochroleuca	80	1
	Cetraria nivalis	50	10

VEGETATION TYPE - ARCTIC WILLOW/DRYAS/VETCH

		PERCENT OCCURRENCE	PERCENT COVER
SHRUBS:	Salix arctica	75	9
	Salix reticulata	66	4
HERBS:	Dryas integrifolia	100	24
	Astragalus umbellatus	95	1
	Astragalus alpinus	61	2
	Lupinus arcticus	85	2
	Parrya nudicaulis	90	tr
	Myosotis alpestris	80	tr
	Pedicularis capitata	66	tr
	Senecia lindstroemii	70	tr
	Polygonum viviparum	61	tr
	Papaver spp.	70	tr
	Saxifraga spp.	66	tr
	Saxifraga punctata	52	tr
	Sausserea angustifolia	47	tr
	Oxytropis nigrescens	52	tr
	Pedicularis lanata	52	tr
	Draba spp.	60	tr
	Minuartia obtusiloba	52	tr
	Polygonum bistorta	42	tr
	Pedicularis spp.	60	tr
GRAMINOIDS:	Carex spp.	66	tr
	Luzula nivalis	47	tr
	Arctagrostis latifolia	47	1.0
	Poa spp.	42	tr
MOSS:	Bryophyte spp.	76	20
LICHEN:	Cetraria cucullata	85	3
	Thamnolia subuliformis	84	3
	Alectoria ochroleuca	84	tr
	Cetraria islandica	57	tr
	Centrari nivalis	52	tr
	Dactylia artica	52	tr
	Alectoria nigricans	47	tr

VEGETATION TYPE - WILLOW/SAXIFRAGE/COLTSFOOT

		PERCENT OCCURRENCE	PERCENT COVER
SHRUBS:	Salix arctica	90	16
	Salix reticulata	55	8
	Salix spp.	40+	tr
HERBS:	Pedicularis spp.	90	tr
	Astragalus umbellatus	75	1
	Polygonum viviparum	80	tr
	Saxifraga hirculus	65	tr
	Senecio spp.	70	tr
	Petasites spp.	65	tr
	Dryas integrifolia	60	11
	Equisetum spp.	50	tr
	Astragalus alpinus	60	1
	Stellaris monantha	55	tr
	Lagotis spp.	50	tr
	Oxytropis	50	tr
	Lupinus arcticus	45	tr
	Valeriana capitata	42	tr
GRAMINOIDS:	Gramineae spp.		
	Arctagrostis latifolia	55	tr
	Festuca spp.	45	tr
	Carex spp.	60	tr
MOSS:	Bryophyte spp.	95	50
LICHEN:	Cetraria cucullata	45	tr
	Cetraria spp.	40	1

VEGETATION TYPE - SEDGE-GRASS

		PERCENT OCCURRENCE	PERCENT COVER
SHRUBS:	Salix spp.	79	1.0
	Salix arctica	43	1
HERBS:	Equisetum spp.	70	1.0
	Pedicularis spp.	70	tr
	Petasites spp.	70	1
	Saxifraga cernua	68	tr
	Saxifraga hirculus	68	1
	Valeriana capitata	43	tr
	Ranunculus spp.	50	tr
	Polemonium spp.	43	tr
	Cruciferae spp.	50	tr
	Caryophllaceae spp.	50	tr
	Rumex spp.	43	tr
GRAMINOIDS:	Carex aquatilis	100	20
	Eriophorum spp.	56	1
	Alopecurus spp.	43	1
	Gramineae spp.	56	1
MOSS:	Bryophyte spp.	87	37
LICHEN:			

VEGETATION TYPE - ARCTIC WILLOW/LUPINE/LOUSEWORT

		PERCENT OCCURRENCE	PERCENT COVER
SHRUBS:	Salix arctica	83	16
	Salix reticulata	83	5
	Salix polaris	50	2
HERBS:	Dryas integrifolia	100	14
	Myosotis alpestris	83	tr
	Polygonum viviparum	100	tr
	Valeriana capitata	83	tr
	Lupinua arcticus	66	5
	Astragalus umbellatus	66	3
	Saxifraga punctata	66	tr
	Aconitum delphinifolium	66	tr
	Artemisia spp.	66	tr
	Parrya nudicaulis	66	tr
	Pedicularia capitata	50	tr
	Polygonum bistorta	100	tr
	Ranunculus spp.	50	tr
	Saxifraga hieracifolia	50	tr
	Astragalus spp.	50	tr
	Oxytropis spp.	50	tr
	Castilleja spp.	50	tr
	Pedicularis spp.	66	tr
GRAMINOIDS:	Poa spp.	83	6
	Carex spp.	83	2
	Luzula nivalis	50	1
	Gramineae spp.	50	tr
MOSS:	Bryophyte spp.	100	35
LICHEN:	Cetraria cucullata	66	2
	Cetraria islandica	50	tr
	Thamnolia spp.	50	tr

VEGETATION TYPE - GRASS CHAMONILE-WORMWOOD

		PERCENT OCCURRENCE	PERCENT COVER
SHRUBS:	Salix arctica	87	9
HERBS:	Artemisia tillesii	75	2
	Matricaria ambigua	75	2
	Myosotis alpestris	62	tr
	Petasites spp.	75	tr
	Cruciferae spp.	87	tr
	Astragalus spp.	62	tr
	Castilleja spp.	62	tr
	Senecia spp.	62	tr
	Pedicularis sudetica	50	tr
	Ranunculus spp.	50	tr
GRAMINOIDS:	Trisetum spicatum	75	2
	Alopecurus alpinus	62	6
	Arctagrostis latifolia	62	7
	Puccinellia spp.	62	3
	Gramineae spp.	62	tr
	Carex spp.	50	tr
MOSS:	Bryophyte spp.	87	12
LICHEN:			

VEGETATION TYPE - SEDGE/MARE'S TAIL-MARSH MARIGOLD

		PERCENT OCCURRENCE	PERCENT COVER
SHRUBS:			
HERBS:	Hippuris spp.	100	20
	Caltha palustris	100	
	Ranunculus spp.	60	1
GRAMINOIDS:	Carex aquatilis	80	7
	Alopecurus spp.	60	2
	Arctagrostis spp.	60	2
	Eriophorum angustifolium	60	2
	Gramineae spp.	60	2
MOSS:	Bryophyte spp.	100	33
LICHEN:			

VEGETATION TYPE - WILD RYE/SANDWORT-LUNGWORT

		PERCENT OCCURRENCE	PERCENT COVER
SHRUBS:			
HERBS:	Honckenya peploides	83	2
	Mertensia maritima	33	tr
GRAMINOIDS:	Elymus arenaria	83	6
MOSS:			
LICHEN:			

VEGETATION TYPE - WILD RYE/SAXIFRAGE-PRIMROSE

		PERCENT OCCURRENCE	PERCENT COVER
SHRUBS:	Salix arctica	66	5
	Salix spp.	44	tr
HERBS:	Matricaria ambiqua	67	tr
	Primula spp.	66	1
	Stellaria spp.	55	tr
	Saxifraqa cernua	44	tr
	Saxifraqe spp.	44	tr
	Senecia spp.	44	tr
	Minuartia spp.		
	Pedicularis spp.		
	Cruciferae spp.		
GRAMINOIDS:	Elymus arenaria	77	5
	Gramineae spp.	66	1
	Carex spp.	66	tr
	Festuca spp.	55	4
MOSS:	Bryophyte spp.	100	36
LICHEN:			

VEGETATION TYPE - SEDGE/CHICKWEED

		PERCENT OCCURRENCE	PERCENT COVER
SHRUBS:			
HERBS:	Stellaria humifosa	70	10
GRAMINOIDS:	Carex spp.	80	5
	Carex subspathaceae	50	5
	Puccinellia spp.		
MOSS:	Algae spp.	40	2
	Bryophyte spp.	50	5
LICHEN:			

VEGETATION TYPE - SORREL-COLTSFOOT-WORMWOOD

		PERCENT OCCURRENCE	PERCENT COVER
SHRUBS:	Salix spp.	50	tr
HERBS:	Achillea millefolium	100	tr
	Artemisia spp.	100	5
	Cruciferae spp.	75	tr
	Minuartia spp.	100	tr
	Myosotis alpestris	100	3
	Oxyria digyna	75	6
	Petasites spp.	100	14
	Ranunculus spp.	75	5
	Saxifraga spp.	100	1
	Erigeron humifosa	50	tr
	Papaver spp.	50	tr
	Parnassia kotzebuei	50	tr
	Polemonium spp.	50	tr
	Senecio lugens	50	tr
GRAMINOIDS:	Alopecurus spp.	100	1
	Poa spp.	75	1
MOSS:	Bryophyte spp.	75	14
LICHEN:			

APPENDIX 3

A listing of all the vascular plants species, organized by families, identified during the Herschel Island ecological inventory.

HERSCHEL ISLAND VASCULAR PLANT SPECIES LIST

Equisetaceae Family

Equistem arvense L.
Equisetum scirpoides Michx.
Equisetum variegatum Schleich.

Alismaceae Family

Sagittaria cuneata Sheld.

Gramineae Family

Alopecurus alpinus J.E. Smith
Arctagrostis latifolia (R.Br.)Griseb.
Arctophila fulva (Trin.)Rupr.
Bromus pumpellianus Scribn.
Dupontia fisheri R.Br.
Elymus arenarius L.
Festuca baffinensis Polunin
Festuca brachyphylla Schultes
Festuca rubra L.
Hierochloe alpina (Sw.)Roem.& Schult.
Poa alpigena (Fr.)Lindm.
Poa arctica R.Br.
Poa glauca M.Vahl
Puccinellia agrostidea Th.Sor.
Puccinellia arctica (Hook.)Fern.& Weath.
Puccinellia langeana (Berl.)Th.Sor.
Puccinellia phryganodes (Trin.)Scribn.& Merr.
Puccinellia vaginata (Lge)Fern.& Weath.
Trisetum spicatum (L.)Richt.

Cyperaceae Family

Carex amblyorhyncha Krecz.
Carex aquatilis Wahlenb.
Carex consimilis Holm
Carex glareosa Wahlenb.
Carex lugens Holm
Carex maritima Gunn.
Carex membranacea Hook.
Carex rariflora (Wahlenb.) Sm.
Carex rupestris All.
Carex scirpoidea Michx.
Carex subspathacea Wormskj.
Carex ursina Dew.
Eriophorum angustifolium Honck.,
Eriophorum scheuchzeri Hoppe
Eriophorum triste (Th. Fr.)Hadac & Love
Eriophorum vaginatum L.
Kobresia hyperborea Porsild
Kobresia myosuroides (Vill.)Fiori & Paol.

Juncaceae Family

Juncus balticus L.
Juncus castaneus Smith
Luzula confusa Lindebl.
Luzula nivalis (Laest.)Beurl.

Liliaceae Family

Allium schoenoprasum L.
Lloydia serotina (L.)Rchb.

Salicaceae Family

Salix arctica Pall.
Salix glauca L.
Salix lanata L.
Salix ovalifolia Trautv.
Salix phlebophylla Anderss.
Salix polaris Wahlenb.
Salix pulchra Cham.
Salix reticulata L.

Betulaceae Family

Betula glandulosa Michx.

Polygonaceae Family

Oxyria digyna (L.)Hill
Polygonum bistorta L.
Polygonum vivparum L.
Rumex acetosa Trautv.
Rumex arcticus Trautv.

Caryophyllaceae Family

Cerastium beeringianum Cham.& Schlecht.
Honckenya peploides (L.)Ehrh.
Melandrium affine J.Vahl
Melandrium apetalum (L.)Fenzl
Minuartia macrocarpa (Pursh)Ostenf.
Minuartia obtusiloba (Rydb.)House
Minuartia rubella (Wahlenb.)Hiern.
Silene acaulis L.
Stellaria edwardsii R.Br.
Stellaria humifusa Rottb.
Stellaria laeta Richards.
Stellaria monantha Hult.

Ranunculaceae Family

Aconitum delphinifolium Dc.
Anemone drummondii S.Wats.
Anemone parviflora Michx.
Anemone richardsonii Hook.
Caltha natans Pall.
Caltha palustris L.
Delphinium glaucum S.Wats.
Ranunculus gmelinii Dc.
Ranunculus nivalis L.
Ranunculus pallasii Schlecht.
Ranunculus pedatifidus Sm.
Ranunculus pygmaeus Wahlenb.
Ranunculus turneri Greene

Papaveraceae Family

Papaver radicatum Rottb.

Cruciferae Family

Cardamine bellidifolia L.
Cardamine digitata Richards.
Cardamine pratensis L.
Cochlearia officinalis L.
Descurainia sophioides (Fisch.)O.E.Schulz
Draba cinerea Adams
Draba corymbosa R.Br.
Draba glabella Pursh
Draba longipes Raup
Erysimum pallasii (Pursh)Fern.
Eutrema edwardsii R.Br.
Parrya arctica R.Br.
Parrya nudicaulis (L.)Regel
Thlaspi arcticum Porsild

Crassulaceae Family

Sedum rosea (L.)Scop.

Saxifragaceae Family

Chrysosplenium tetrandrum (Lund)Fries
Parnassia kotzebuei Cham.& Schlecht.
Saxifraga cernua L.
Saxifraga flagellaris Willd.
Saxifraga foliolosa R.Br.
Saxifraga hieracifolia Waldst.& Kit
Saxifraga hirculus L.

Saxifragaceae Family continued

Saxifraga oppositifolia L.
Saxifraga punctata L.
Saxifraga reflexa Hook.
Saxifraga tricuspidata Rottb.

Rosaceae Family

Dryas integrifolia M. Vahl
Geum glaciale Adams
Geum rossii (R.Br.)Ser.
Potentilla egedii Wormskj.
Potentilla nivea L.
Potentilla palustris (L.)Scop.
Potentilla uniflora Ledeb.
Rubus chamaemorus L.

Leguminosae Family

Astragalus aboriginum Richards.
Astragalus alpinus L.
Astragalus eucosmus Robins.
Astragalus umbellatus Bunge
Hedysarum alpinum L.
Lupinus arcticus S.Wats.
Oxytropis arctica R.Br.
Oxytropis campestris (L.)DC.
Oxytropis deflexa (Pall.)DC.
Oxytropis nigrescens (Pall.)Fisch.

Empetraceae Family

Empetrum nigrum L.

Haloragaceae Family

Hippuris tetraphylla L.
Hippuris vulgaris L

Umbelliferae Family

Bupleurum americanum Coult.& Rose
Conioselinum cnidiifolium (Turcz.)Porsild

Pyrolaceae Family

Pyrola grandiflora Radius

Ericaceae Family

Arctostaphylos alpina (L.)Spreng.
Arctostaphylos rubra (Rehd.& Wilson)Fern.
Cassiope tetragona (L.)D.Don
Ledum decumbens (Ait.)Lodd.
Ledum groenlandicum Oeder
Rhododendron camtschaticum Pall.
Vaccinium uliginosum L.
Vaccinium vitis-idaea L.

Primulaceae Family

Androsace chamaejasme Host
Androsace septentrionalis L.
Dodecatheon frigidum Cham.& Schlecht.
Primula borealis Duby

Gentianaceae Family

Gentinana propinqua Richards.
Lomatogonium rotatum (L.)Fries

Polemoniaceae Family

Polemonium acutiflorum Willd.
Polemonium boreale Adams

Boraginaceae Family

Mertensia maritima (L.)Gray
Myosotis alpestris F.W.Schmidt

Scrophulariaceae Family

Castilleja caudata (Pennell)Rebr.
Castilleja elegans Malte
Castilleja hyperborea Pennell
Lagotis glauca Gaertn.
Lagotis stelleri (Cham.& Schlecht.)Rupr.
Pedicularis arctica R.Br.
Pedicularis capitata Adams
Pedicularis lanata Cham.& Schlecht.
Pedicularis langsdorffii Fisch.
Pedicularis oederi M.Vahl
Pedicularis sudetica Willd.
Pedicularis verticillata L.

Valerianaceae Family

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Valeriana capitata Pall.

Compositae Family

Ahcillea millefolium L.
Achillea nigrescens (E.Mey.)Rydb.
Antennaria ekmaniana Porsild
Arnica alpina (L.)Olin
Artemisia arctica Leass.
Artemisia tilesii Ledeb.
Chrysanthemum arcticum L.
Erigeron grandiflorus Hook.
Erigeron humilis Graham
Erigeron purpuratus Greene
Matricaria ambigua (Ledeb.)Kryl.
Petasites frigidus (L.)Franch.
Petasites hyperboreus Rydb.
Saussurea angustifolia (Willd.)DC.
Senecio atropurpureus (Ledeb.)Fedtsch.
Senecio congestus (R.Br.)Dc.
Senecio conterminus Greenm.
Senecio lindstroemii (Ostenf.)Porsild
Senecio lugens Richards.
Senecio resedifolius Less.
Taraxacum alaskanum Rydb.
Taraxacum phymatocarpum J.Vahl

APPENDIX 4

Data were collected from transects composed of 10 observation sites equally-spaced along the long axis of each of 15 map polygons. At each site the persent slope, percent bare ground (exposed soil), the vegetation type, depth (cm) to $CaCO_3$ (as detectable by 10% HC) and the field pH were recorded. A value of NO under depth to $CaCO_3$ means none detected, value of 0 means $CaCO_3$ detected at the soil surface.

Vegetation type numbers are as follows:

1. Cottongrass/Moss
2. Arctic Willow/Dryas-Vetch
3. Willow/Saxifrage-Coltsfoot
4. Sedge-Grass/Moss
5. Arctic Willow/Lupine-Forget-me-not
6. Grass/Chamomile-Wormwood
7. Wild Ray/Saxifrage-Primrose
8. Sedge/Chickweed
9. Wild Ray/Sandwort-Lungwort
10. Sedge/Mare's Tail- Marsh Marigold
11. Sorrel-Coltsfoot-Wormwood

MAP UNIT	TRANS #	OBS #	% SLOPE	% BARE GRND	DEPTH TO FROST	DRNG	COMM TYPE	DEPTH TO LIME	PH
OR	01	01	02	00	043	I	03	NO	6.5
OR	01	02	02	00	043	I	03	NO	6.8
OR	01	03	01	00	048	I	03	NO	6.8
OR	01	04	01	00	044	I	03	NO	6.6
OR	01	05	01	00	043	I	03	NO	6.8
OR	01	06	01	00	056	I	03	0	6.9
OR	01	07	01	35	055	I	03	0	6.8
OR	01	08	01	05	057	P	04	0	6.8
OR	01	09	01	10	048	I	03	0	6.9
OR	01	10	01	01	057	I	03	0	7.0
TH	02	01	67	70	080	W	05	0	7.6
TH	02	02	17	20	058	W	05	0	7.3
TH	02	03	11	60	060	MW	05	0	7.4
TH	02	04	18	50	065	W	05	0	7.6
TH	02	05	19	25	055	W	05	0	7.5
TH	02	06	25	75	055	W	06	0	7.5
TH	02	07	25	25	058	MW	05	0	7.2
TH	02	08	24	65	061	W	05	0	7.2
TH	02	09	20	50	058	W	06	0	7.3
JA	03	01	10	10	058	MW	02	0	7.0
JA	03	02	12	05	054	MW	03	0	7.1
JA	03	03	10	05	026	I	02	0	7.1
JA	03	04	15	25	050	I	03	0	7.2
JA	03	05	13	01	026	I	02	NO	7.2
JA	03	06	09	05	056	MW	03	0	7.4
JA	03	07	10	01	042	I	03	4	7.3
JA	03	08	20	05	047	I	03	0	7.1
JA	03	09	17	05	040	MW	02	NO	6.7
JA	03	10	20	01	040	MW	02	10	6.5
OR	04	01	04	01	045	I	03	40	6.3
OR	04	02	04	01	042	I	03	25	6.5
OR	04	03	05	05	055	I	03	0	7.1
OR	04	04	10	05	050	I	03	0	7.2
OR	04	05	18	05	050	I	03	9	7.1
OR	04	06	12	01	045	I	03	0	7.1
OR	04	07	09	01	028	I	03	0	7.0
OR	04	08	07	01	047	I	03	0	7.1
OR	04	09	08	05	040	P	04	NO	6.9
OR	04	10	07	01	049	P	03	0	7.0
OR	04	11	02	01	050	P	11	0	NA

MAP UNIT	TRANS #	OBS #	% SLOPE	% BARE GRND	DEPTH TO FROST	DRNG	COMM TYPE	DEPTH TO LIME	PH
GU	05	01	02	05	026	P	04	NO	6.0
GU	05	02	02	05	023	P	04	NO	5.0
GU	05	03	01	05	035	P	04	NO	5.0
GU	05	04	01	05	022	P	04	NO	5.4
GU	05	05	03	01	031	VP	04	NO	5.1
GU	05	06	02	01	028	VP	04	NO	5.8
GU	05	07	02	01	022	VP	04	NO	4.8
GU	05	08	03	01	014	P	04	NO	4.6
GU	05	09	02	01	023	P	01	NO	5.3
GU	05	10	01	01	013	P	01	NO	5.0
HE	06	01	04	01	020	I	01	NO	4.6
HE	06	02	04	05	021	I	01	NO	4.0
HE	06	03	05	01	018	I	01	NO	4.5
HE	06	04	05	01	020	I	01	NO	4.4
HE	06	05	05	01	022	I	01	NO	4.6
HE	06	06	06	01	017	I	01	NO	4.7
HE	06	07	05	01	021	I	01	NO	4.6
HE	06	08	05	00	028	I	01	NO	4.8
HE	06	09	05	05	027	I	01	NO	5.4
HE	06	10	06	01	023	I	01	NO	5.8
PL	07	01	13	35	021	MW	02	0	7.0
PL	07	02	12	30	038	MW	02	0	7.0
PL	07	03	11	40	040	MW	02	0	7.0
PL	07	04	10	40	046	MW	02	0	7.2
PL	07	05	10	35	048	MW	02	0	6.9
PL	07	06	09	35	041	MW	02	0	7.2
PL	07	07	14	45	037	MW	02	0	7.0
PL	07	08	09	35	026	MW	02	0	7.1
PL	07	09	10	40	045	MW	02	0	7.1
PL	07	10	09	40	036	MW	02	0	7.1
KO	08	01	06	10	051	MW	02	0	7.2
KO	08	02	10	10	040	MW	02	0	7.2
KO	08	03	10	15	046	MW	02	0	7.2
KO	08	04	09	20	048	MW	02	0	7.3
KO	08	05	08	15	034	MW	02	5	7.1
KO	08	06	06	10	035	I	03	NO	6.3
KO	08	07	05	05	015	P	01	NO	5.6
KO	08	08	03	01	020	P	01	NO	5.3
KO	08	09	04	01	014	P	01	NO	5.4
KO	08	10	04	10	022	I	01	NO	6.0

MAP UNIT	TRANS #	OBS #	% SLOPE	% BARE GRND	DEPTH TO FROST	DRNG	COMM TYPE	DEPTH TO LIME	PH
PL	09	01	05	60	048	W	02	0	7.2
PL	09	02	02	35	038	W	02	0	6.9
PL	09	03	02	20	034	W	02	NO	6.5
PL	09	04	05	50	035	W	02	2	5.5
PL	09	05	09	50	033	W	02	0	7.0
PL	09	06	05	50	040	W	02	0	7.1
PL	09	07	05	30	032	MW	02	0	6.4
PL	09	08	02	25	034	MW	02	NO	6.1
PL	09	09	07	20	029	MW	02	NO	6.5
PL	09	10	06	40	042	MW	02	NO	6.3
TH	10	01	55	50	060	W	06	0	7.7
TH	10	02	23	60	056	W	03	0	7.5
TH	10	03	30	50	047	W	06	0	7.4
TH	10	04	25	35	058	MW	06	0	7.3
TH	10	05	45	25	047	MW	11	NO	7.3
TH	10	06	35	80	046	W	11	0	7.4
TH	10	07	44	60	046	MW	11	NO	7.3
TH	10	08	96	95	060	W	06	0	7.6
TH	10	09	70	99	055	W	00	0	7.8
TH	10	10	55	55	052	W	11	0	7.4
JA	11	01	07	05	040	MW	5	0	7.4
JA	11	02	09	01	038	MW	03	0	7.5
JA	11	03	13	10	030	MW	02	0	7.3
JA	11	04	14	20	035	MW	02	0	7.6
JA	11	05	10	10	033	MW	02	0	7.6
JA	11	06	09	00	030	M	03	0	7.5
JA	11	07	20	05	049	MW	05	5	7.5
JA	11	08	10	60	060	MW	12	0	7.5
JA	11	09	07	15	035	MW	02	NO	7.2
JA	11	10	07	05	027	MW	05	NO	7.4
GU	12	01	00	00	015	I	01	NO	5.7
GU	12	02	00	00	015	I	01	NO	4.9
GU	12	03	00	00	005	I	01	NO	5.3
GU	12	04	00	05	020	I	01	NO	5.5
GU	12	05	01	05	023	I	01	NO	6.0
GU	12	06	01	00	033	P	04	NO	6.4
GU	12	07	00	00	030	P	04	NO	6.1
GU	12	08	01	00	016	P	01	NO	5.5
GU	12	09	00	00	023	VP	04	NO	5.8
GU	12	10	00	00	015	I	04	NO	5.6

MAP UNIT	TRANS #	OBS #	% SLOPE	% BARE GRND	DEPTH TO FROST	DRNG	COMM TYPE	DEPTH TO LIME	PH
HE	13	01	01	15	048	MW	01	NO	5.6
HE	13	02	02	20	032	MW	01	NO	6.0
HE	13	03	01	15	023	MW	01	NO	5.8
HE	13	04	03	15	032	MW	01	NO	5.8
HE	13	05	02	15	028	MW	01	NO	5.9
HE	13	06	04	10	030	MW	01	NO	5.8
HE	13	07	02	20	033	MW	01	NO	6.2
HE	13	08	02	20	022	MW	01	NO	5.9
HE	13	09	03	10	037	MW	01	NO	5.9
HE	13	10	01	01	024	MW	01	NO	5.6
KO	14	01	08	05	030	MW	02	NO	5.1
KO	14	02	06	04	039	MW	02	NO	5.2
KO	14	03	05	06	041	MW	02	NO	4.7
KO	14	04	04	10	032	MW	02	NO	5.3
KO	14	05	04	15	043	MW	02	NO	5.2
KO	14	06	03	18	034	W	02	NO	7.2
KO	14	07	04	12	040	W	02	NO	5.0
KO	14	08	02	15	030	MW	02	NO	5.1
KO	14	09	04	15	033	W	02	NO	6.4
KO	14	10	03	12	027	MW	02	NO	6.3
HE	15	01	03	05	026	I	01	NO	4.5
HE	15	02	03	05	033	I	01	NO	4.2
HE	15	03	04	05	029	I	01	NO	4.2
HE	15	04	02	03	030	I	01	NO	4.4
HE	15	05	00	04	020	P	01	NO	4.5
HE	15	06	03	04	023	I	01	NO	4.4
HE	15	07	01	02	017	P	01	NO	4.8
HE	15	08	00	10	023	P	01	NO	4.4
HE	15	09	03	00	018	P	01	NO	4.6
HE	15	10	01	10	020	P	01	NO	4.2

MAPS
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